United States Department of Agriculture

Final Environmental Impact Statement

for the Malheur, Umatilla, and Wallowa-Whitman National Forests Land Management Plans

Volume 1: Chapters 1, 2, and 3 (part 1)

Forest Service Pacific Northwest Region July 2018

Final Environmental Impact Statement
Land Management Plans
for the
Umatilla, Malheur, and Wallowa-Whitman National Forests

Baker, Crook, Grant, Harney, Malheur, Morrow, Umatilla, Union, Wallowa, and Wheeler Counties, Oregon
Asotin, Columbia, Garfield, and Walla Walla Counties, Washington

Lead Agency: USDA Forest Service

Cooperating Agencies:

Grant County, Oregon
Harney County, Oregon
Morrow County, Oregon
Umatilla County, Oregon
Union County, Oregon
Wallowa County, Oregon
Wheeler County, Oregon
Asotin County, Washington
Columbia County, Washington
Garfield County, Washington

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Website: http://www.fs.usda.gov/goto/BlueMtnsPlanRevision

Abstract

This Final Environmental Impact Statement documents the analysis of eight alternatives (Alternatives A through F) developed by the Forest Service for the programmatic management of approximately 5.5 million acres of National Forest System lands administered by the Malheur,[1] Umatilla, and Wallowa-Whitman National Forests.

The purpose of and need for action to revise the forest plans is as follows:
(1) to more adequately protect and restore terrestrial plant and animal species and their habitats;
(2) to address management of fuels and fire risk;
(3) to more adequately protect and restore watersheds and aquatic habitats;
(4) to address climate change; and
(5) to recognize the interdependency of social and economic components with national forest management.

The alternatives are described in Appendix A, Volume 4. Alternative A is a no-action alternative that would keep in place the management direction from each national forest's 1990 land and resource management plan, as amended. Alternative B is a modified version of the original proposed action. In the Draft Environmental Impact Statement, Alternatives C, D, E and F were developed to address one or more of the significant issues the Forest Service identified from comments received during the initial public involvement period. Following the comment period to the Draft Environmental Impact Statement, the Forest Service modified Alternative E to form two additional alternatives, E-Modified and E-Modified Departure, analyzed in the Final Environmental Impact Statement. Alternative E-Modified is the agency's preferred alternative.

The Forest Service will use the predecisional administrative review process, also referred to as the "objection process" described in 36 CFR 219 Subpart B of the 2012 Planning Rule to give individuals or organizations an opportunity for an independent Forest Service review and resolution of objections before the approval of a plan revision. Individuals and entities who have submitted substantive formal comments related to this plan revision during any of the opportunities for public comment for this project may file an objection.
More information is available on the Blue Mountains Forest Plan Revision website at: http://www.fs.usda.gov/goto/BlueMtnsPlanRevision

[1] Includes a portion of the Ochoco National Forest administered by the Malheur National Forest.

Preface

Changes between the Draft and Final Environmental Impact Statements

The Draft Environmental Impact Statement was released for comment in February 2014. From more than 1,100 letters the Forest Service received from the public, over 4,300 comments were identified. As a result of those comments and following discussions in meetings with collaborators and cooperators, the Forest Service made the following changes within the Final Environmental Impact Statement.

Two More Alternatives Analyzed

Alternative E-Modified is the result of multiple comments made about the need for more timber production on the Malheur, Umatilla, and Wallowa-Whitman National Forests. This alternative addresses recommendations to remove timber at a faster pace and scale than was originally proposed in Alternative E in the Draft Environmental Impact Statement. Along with a faster pace and scale for timber harvest, Alternative E-Modified focuses on comments about watershed restoration to promote landscape health and forest resiliency to provide improved socio-economic conditions in the long term (beyond two decades) within each of the National Forests. Alternative E-Modified is the new preferred alternative and it is described in detail in each National Forest's Revised Forest Plan, as well as in Chapter 2 of this document. This alternative also results from comments and discussions to include the historic animal unit months (AUMs) and suitable acres of rangeland for vacant allotments. The updated Aquatic and Riparian Conservation Strategy (2018 Blue Mountains ARCS) is included in this alternative.

Alternative E-Modified Departure was developed in response to requests for improved socio-economic conditions, and to improve forest age-class distributions that would attain desired conditions more rapidly than Alternative E or Alternative E-Modified. This alternative has plan components identical to Alternative E-Modified. Differences exist within the timeframe for removal (this alternative would remove the timber within the life of the plan, estimated to be two decades) and proposes more timber removed. The strategy behind the faster pace and scale is to remove the timber via harvest, before timber might be exposed to insects and diseases or removed by wildfire. This alternative also results from comments and discussions to include the historic AUMs and suitable acres of rangeland for vacant allotments. The 2018 Blue Mountains ARCS is included in this alternative.

Individual Plans for each National Forest

One consolidated forest plan for the three national forests was made available for review along with the publication of the Draft Environmental Impact Statement. The consolidated forest plan has been separated into three separate forest plans for the administrative area of each National Forest based on the agency preferred alternative to accompany the Final Environmental Impact Statement.

Updates to the Aquatic and Riparian Conservation Strategy

Appendix A in each Forest Plan, contains the 2018 Blue Mountains Aquatic and Riparian Conservation Strategy (2018 Blue Mountains ARCS). This document was formulated with public comments received from the February 2014 Draft Environmental Impact Statement that were added to the 2008 Regional Aquatic and Riparian Conservation Strategy. The strategies in the 2018 Blue Mountains ARCS apply only to the two additional alternatives: Alternative E-Modified

and Alternative E-Modified Departure. Alternatives B through F would still be follow the guidance of the original 2008 Regional ARCS. Compared to the 2008 Regional ARCS, the 2018 Blue Mountains ARCS adds some new standards and guidelines, and changes some existing guidelines to standards and vice versa.

Assessments referred to in the 2018 Blue Mountains ARCS would be conducted using the National Watershed Condition Framework.[2] Refer to Appendix A of each Forest Plan to review the 2018 Blue Mountains ARCS for more details.

Overall Changes to the Document and Analysis

We received many comments about the length, clarity, organization, and readability of the Draft Environmental Impact Statement. As a result, the following changes have been made:

- Methodology information has been moved from the appendix to applicable resource analysis sections in this Final Environmental Impact Statement, and more information using best available science has been added where appropriate.
- Changes made to each resource analysis section between the Draft and Final Environmental Impact Statements are described in each resource analysis section.
- Explanations of methods and rationale where requested from commenters have been added, as well as removing repetitious material. Additionally, more definitions have been added to the glossary, and footnotes were added for quick references. Most acronyms were eliminated by spelling words out.
- Chapter 3 of the Draft Environmental Impact Statement had “Forest Vegetation, Timber Resources and Wildland Fire” in one section. In response to public comments about organization and clarity, we split that section into “Forest Vegetation,” “Timber and Forest Products,” “Insects and Disease,” and “Wildland Fire and Fuels Treatments.”
- To help readers find important conclusions, we have provided them in the Summary, which is now available as a separate document.

Changes in Species Classification Labeling

Some terminology has been changed between the Draft and Final Environmental Impact Statements to reduce confusion and provide updates based on best available scientific information. Both the terrestrial and aquatic sections of the Draft Environmental Impact Statement referred to “species of conservation concern,” which has a specific definition and process for selection under the 2012 Planning Rule that is not applicable to the plans revised under the 1982 Planning Rule. To avoid confusion with the 2012 Planning Rule and its implementing regulations, “species of conservation concern” is not used in this Final Environmental Impact Statement. Instead, the following categories are used:

- **Management Indicator Species -** The Blue Mountain Forest Plan Revision process used management indicator species for the purpose of assessing the impacts of the alternatives on wildlife and fish populations as directed in the 1982 Planning Rule (CFR 219.19 (a) (1) and (2)). The no-action alternative (no change in current management) was evaluated in terms of the management indicator species listed in the 1990 forest plans. New management indicator species were selected and analyzed for the plan revision alternatives.

[2] See information about the Watershed Condition Framework at https://www.fs.fed.us/biology/watershed/condition_framework.html

- **Focal Species -** Although this plan revision was developed under the provisions of the 1982 Planning Rule, it is required that all land management plans be updated to include a monitoring strategy that addresses the status of focal species as directed in the 2012 Planning Rule (36 CFR 219.12 (c) (1)). Focal species are not intended to be a proxy for other species. Instead, they are species whose presence, numbers, or status are useful indicators that are intended to provide insight into the integrity of the larger ecological system, the effects of management on those ecological conditions, and the effectiveness of plan components to provide for the diversity of plant and animal communities.
- **Surrogate Species -** These species were referred to as "focal species" in the Draft Environmental Impact Statement but the name was changed to surrogate species to avoid confusion with focal species as defined in the monitoring program requirements of the 2012 Planning Rule. Surrogate species serve an umbrella function in terms of encompassing habitats needed for other species, are sensitive to the changes likely to occur in the area, or otherwise serve as an indicator of ecological sustainability. The long-term sustainability of the surrogate species is assumed to be representative of a group of species with similar ecological requirements and this group is assumed to respond in a similar manner to environmental change (Suring et al. 2011).

See the species definition categories listed in the Terrestrial Wildlife section in Volume 2 under the "Regulatory Framework" section. These categories fully comply with the 1982 Planning Rule, the National Forest Management Act, the 2012 Planning Rule monitoring program development (CFR 219.12), and the obligation to use best available science. It is important to note that species can fall within one or more of the groups defined. For example, the white-headed woodpecker is a management indicator species, a focal species, and a surrogate species.

Additional Cumulative Effects Analysis

A cumulative effects analysis has been added related to the 2003 Comprehensive Management Plan for the Hells Canyon National Recreation Area, which is incorporated by reference into the Wallowa-Whitman's Revised Forest Plan. The analysis related to management of the national recreation area is presented for impacts related to guidance and direction of the Inland Native Fish Strategy and the Pacific Anadromous Fish Strategy (INFISH and PACFISH).

Additional Relevant Best Available Science Literature

Many comments were received and heard on the Draft Revised Plan and Environmental Impact Statement that questioned the relevance and timeliness of the science used to support positions or assumptions. To better address these concerns numerous additional references to relevant science literature have been included in the discussions. Some of these relevant documents and reports are quite recent and were not included or were not yet available when the Draft Plan and Environmental Impact Statement documents were being prepared. Others are included and cited to further support or provide additional examples of the ideas being discussed.

The planning record (40 CFR 1502.21) is incorporated by reference throughout this document. The planning record contains specialist reports and other technical documentation used to support the analysis and conclusions in this Final Environmental Impact Statement. The planning record is available for review at the Wallowa-Whitman National Forest, Forest Supervisor's Office, 1550 Dewey Ave., Suite A, Baker City, Oregon 97814.

Document Structure

The layout and contents within this Final Environmental Impact Statement are as follows:

Summary

The independent Summary provides information about the changes between the Draft and Final Environmental Impact Statements, a synopsis of the issues and alternatives, and key conclusions from the analysis.

Volume 1

Chapter 1. Background and Introduction: Chapter 1 includes the complete history of the proposal, including the need to change the existing plan, environmental and regulatory compliance, and the public involvement process that helped in development of issues, alternatives, and modifications to the draft proposed plan.

Chapter 2. Alternatives, including the Proposed Action: Chapter 2 provides a detailed description and explanations for each of the alternatives along with support for why they were developed (as requested in comment letters by the public). A summary comparison of alternatives is provided at the end of Chapter 2 and also in Appendix A of this Final Environmental Impact Statement.

Chapter 3. **Affected Environment and Environmental Consequences (part 1)**: The current conditions on the Malheur (including the portion of the Ochoco administered by the Malheur), Umatilla, and Wallowa-Whitman National Forests are described, as well as the environmental consequences of implementing each alternative at a programmatic level.

Two additional alternatives: (1) Alternative E-Modified and (2) Alternative E-Modified Departure, are analyzed in detail in this Final Environmental Impact Statement, in addition to the alternatives analyzed in the draft. However, only issues brought forth in comments by the public where more clarification is needed have been added to Alternatives A, B, C, D, E, and F.

Volume 2

Chapter 3. Continued.

Volume 3

Chapter 4. Public, Governmental and Tribal Involvement; List of Preparers; and Distribution of the Environmental Impact Statement: This chapter provides a list of preparers and agencies consulted during the development of this Final Environmental Impact Statement.

References: Only references cited in this Final Environmental Impact Statement are provided in the “References” section.

Glossary and Acronyms: The glossary from the Draft Environmental Impact Statement was modified to add definitions for new terms used in this document along with, at the request of public in comment letters, some new definitions for terms that were not defined in the Draft Environmental Impact Statement.

Volume 4

Appendices: The appendices provides additional detailed information in support of the analyses presented in the Final Environmental Impact Statement.

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Chapter 1. Introduction and Background

Introduction

The U.S. Department of Agriculture, Forest Service, prepared this Final Environmental Impact Statement in compliance with the National Environmental Policy Act (1969), and other relevant Federal and State laws and regulations. This document discloses the environmental consequences that could result from the proposed action of revising the land management plans for the Malheur, Umatilla, and Wallowa-Whitman National Forests and alternatives to the proposed action.

The Malheur, Umatilla, and Wallowa-Whitman National Forests are located in northeast Oregon and southeast Washington (Figure 1). The land within the administrative boundaries of the three National Forests consists of 5.5 million acres of National Forest System lands. The Forest Service administers:

- the 1.5 million-acre Malheur National Forest and an adjoining 242,000-acre portion of the Ochoco National Forest as one administrative unit;
- the 1.4 million-acre Umatilla National Forest; and
- the 2.4 million-acre Wallowa-Whitman National Forest.

All of these National Forest System lands are in Oregon with the following two exceptions: the Umatilla National Forest includes 311,000 acres in southeast Washington and the Wallowa-Whitman National Forest includes the Hells Canyon National Recreation Area, which straddles the Oregon-Idaho border. See more about the Hells Canyon National Recreation Area and how it relates to the Forest Plan Revision process under "Relationship to Other Assessments," "Forestwide Scale" in this same chapter.

Background

The first planning rule for the Forest Service was established in 1982, setting forth direction for national forests to create land management plans (hereafter referred to as "forest plans"). The Malheur, Umatilla, and Wallowa-Whitman National Forests released their first forest plans in 1990.

In the year 2000, a new planning rule was issued. In 2003, the Malheur, Umatilla, and Wallowa-Whitman National Forests (also referred to as the "Blue Mountains national forests") began efforts to revise their forest plans. Between then and now, the planning rule changed several times[3] due to litigation and changing presidential administrations:

- An interpretive rule was published in 2004 allowing all national forests to use the 1982 Planning Rule over the 2000 Planning Rule for forest plan revisions and amendments.
- A 2005 Planning Rule was published, superseding the 2004 interpretive rule, then again in 2008 another planning rule was published, superseding the 2005 Planning Rule.
- In 2009, a U.S. District Court decision in California overturned the 2008 Planning Rule and the Forest Service returned to transition provisions of the 2000 Planning Rule, thus allowing continued use of the 1982 Planning Rule for forest plan revisions and amendments.

[3] See the history of the planning rule at: https://www.fs.usda.gov/main/planningrule/history

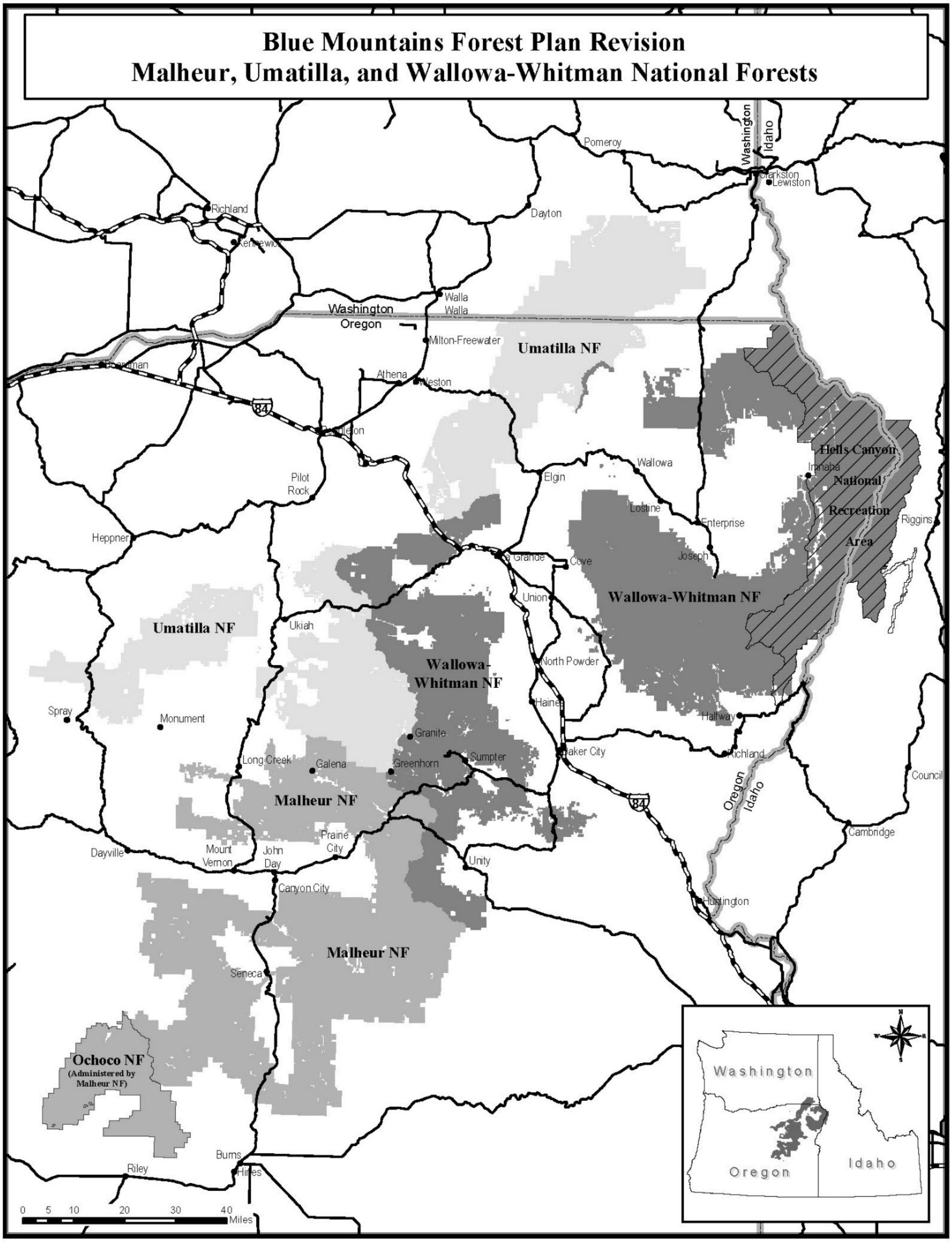


Figure 1. Vicinity map of the National Forests in the Blue Mountains

- In 2012, the Forest Service published a final planning rule, which contains transition language allowing forest plan revisions started under the 1982 Planning Rule to finish using the 1982 process.
- In February 2014, the Blue Mountains national forests released a Proposed Revised Plan and a Draft Environmental Impact Statement.

It is important to note that the since the Draft Environmental Impact Statement was released, the Forest Service has decided to prepare three separate revised forest plans, one plan for each of the three National Forests. It is also important to note that the plans and environmental impact statement have been prepared using the 1982 Planning Rule process with the exception of two items in accordance with the 2012 Planning Rule:

- **The Forest Service will use the pre-decisional administrative review process, also referred to as the "objection process" prior to issuing a final decision.**[4] This process gives an individual or entity an opportunity for an independent Forest Service review with resolution of issues before the approval of a land management plan.

  Subpart B of the 2012 Planning Rule:

  a. Identifies and shows how an individual may file objections to a plan revision;
  b. Explains the responsibilities of the participants in an objection; and
  c. Defines the procedures that apply to the review of the objection.

  The 2012 Planning Rule at section 219.53 explains eligibility requirements to file an objection. Individuals and entities who have submitted substantive formal comments during the opportunities for public comment for this decision may file an objection.

- **A monitoring program for the Plan Area included with each Forest Plan will follow requirements of the 2012 planning regulation at 36 CFR 219.12.** Monitoring allows responsible officials to test assumptions, track changing conditions, measure management implementation and effectiveness in achieving desired outcomes, and feed new information back to inform adaptive management. The key role that monitoring serves in adaptive management is that it provides the opportunity for facilitated learning to measure progress toward desired conditions and objectives of the land management plan as well as measuring effectiveness of plan components.[5]

  Modifying a plan's monitoring program does not require any change to the plan; that is, a plan need not be amended or revised simply to facilitate monitoring according to the 2012 Planning Rule.[6] One purpose of monitoring and evaluation is to ensure that management direction is being carried out, and that the outputs and schedules are being achieved. However, if monitoring shows continued conflicts or problems in implementing the management direction, a Forest Plan amendment to address conflicts or problems with the management direction may be necessary.

[4] See 36 CFR 219, subpart B of the 2012 Planning Rule
[5] Forest Service Handbook 1909.12, zero code, Section 06
[6] Forest Service Handbook 1909.12, Chapter 30, Section 32.3

The Need to Change the 1990 Forest Plans

The existing Forest Plans for the three National Forests are almost 30 years old. Economic, social, and ecological conditions have changed during that time; new laws, regulations and policies are in place; and new information based on monitoring and scientific research is available. The following sections explain many of the subjects that contributed to the need to change the existing Forest Plans beyond those created in the 1990s and to update information beyond the Draft Environmental Impact Statement to this Final Environmental Impact Statement being released with the Malheur, Umatilla, and Wallowa-Whitman Revised Forest Plans.

A Need to Consider the Effects of Climate Change

The Council on Environmental Quality noted in February 2010 that agencies should recognize the scientific limits of their ability to accurately predict climate change effects, especially of a short-term nature, and not devote effort to analyzing wholly speculative effects. In December of 2014 they also recommended that agencies provide reasoned analyses and that they provide an explanation of determinations being made.

There is a need for Forest Service specialists to understand past climate trends to see how and at what incremental variations weather patterns are occurring. Then, when analyses are prepared, the correct historical data and scientific sources are referenced so others can verify the information if, and when, desired. For a repeatable prediction (which is what specialists must do when making recommended components for a Forest Plan two decades into the future), it is necessary to compare multiple trends (for example, last century's temperature trend compared to that of the last 5 years). Without doing this type of comparison, it could be assumed that the next two decades might be similar to the last two decades, and as the section "Climate" in Chapter 3 will show, that is not the case.

To then make predictions (using the best science available for what might occur, in the next two decades based on what has occurred), one of the options available is to use modeling and to consider ranges of high, moderate, and low (because predictions are not guarantees). For more information on how climate change is affecting national forest management, see the Forest Service Climate Change Website at: https://www.fs.fed.us/climatechange/.

Energy Policy Act of 2005

This act, which was passed after the start of the Forest Plan revision process, requires agencies to consider various energy projects, such as wind energy. Wind energy development is considered a special use of the national forests. All special uses must be consistent with Forest Plan components, including desired conditions for scenery, watershed function, species diversity, cultural resources, and water quality. Special use proposals must undergo site-specific analyses that will determine their consistency with Forest Plan direction.

From more than 1,100 comment letters on the Draft Environmental Impact Statement, there were a multitude of comments saying "no" to development of wind projects on any of the three National Forests, with the exception of one letter, where there was an interest. For more information on wind projects, see: https://www.fs.fed.us/sustainableoperations/.

It was stated in the Draft Environmental Impact Statement, that some people expressed concern about potential energy developments within the Blue Mountains national forests during the 2010 scoping period, specifically about the potential for oil and gas development. Oil and gas availability and leasing determinations are not made during forest plan revision. A suitability

determination for energy development, however, will be included in the three revised Forest Plans.

Using Best Available Science

What constitutes best available science might vary over time and across scientific disciplines. As a general matter, best available science can be shown when up-to-date research is considered and disclosed in analyses. Specifically, documents should identify methods used, reference scientific sources relied on, discuss responsible opposing views, and disclose incomplete or unavailable information, scientific uncertainty, and risk.[7]

The Forest Service has a long history of science-based decision-making. Using scientific information in planning provides the authorized official with the knowledge, methods, and expert review needed to make an informed decision. To ensure that land management planning decisions help contribute to sustainable stewardship and ecological integrity of the nation's national forests, the agency needs to show they have taken into account the best available scientific information pertaining to the economic and social conditions and ecosystem composition, structure, and function. Interestingly, and certainly a benefit for those who value efficiency, using best available science became more feasible in 2003, after Web 2.0 was introduced and information was easier to share and be found through the internet.

For the Blue Mountains national forests, scientific studies in this analysis included science supporting the Interior Columbia Basin Management Project (Quigley et al. 1996, 1997). Although the 105th Congress's decision on March 10, 1998 was to halt the Interior Columbia Basin Management Project, there was a Memorandum of Understanding agreed upon between several government agencies, which included the Forest Service, to continue use for and of the science that was referenced during development of the Project as needed and appropriate in future and relevant projects as "best science available." A Final Environmental Impact Statement and Proposed Decision for the Interior Columbia Basin Ecosystem Management Project were published in December 2000. The State Directors and Regional Foresters elected not to prepare a Record of Decision and instead chose to complete the Project through use of "The Interior Columbia Basin Strategy." The Interior Columbia Basin Strategy provides principles that incorporate the science data and resource information developed by the project, as well as more recent science, into land use plans (Forest Service Land and resource management plans and Bureau of Land Management resource management plans) and project implementation. The Interior Columbia Basin Strategy identifies key principles that are relevant to future planning efforts including an update of ecological principles. For more information, go to: https://icbemp.gov/html/ICBEMP_Frameworkmemorandum-and-strategy_2014.pdf

In addition, the specialists on the planning team have used and referenced a number of other appropriate scientific information, models, and data to develop the analyses and conclusions in this Final Environmental Impact Statement. This science has been continually updated throughout the plan revision and environmental analysis process.

[7] See Council on Environmental Quality regulations at 40 CFR 1502.9 (b), 1502.22, 1502.24.

The Need for More Management Flexibility

The Blue Mountains Forest Plans have all been amended numerous times:

- Malheur: amended 84 times
- Umatilla: amended 35 times
- Wallowa-Whitman: amended 53 times

The vast number of amendments substantiates the need for revising the Forest Plans, as does the many events and circumstances that have changed since they were last written in 1990.

Several of the amendments made to the Forest Plans since 1990 have been to accommodate changes that occurred for Forest-wide protection of species and habitat associated with the Eastside Screens,[8] PACFISH and INFISH. Initially intended as interim direction (to be less than 2 years) to stay in place until work on the Interior Columbia Basin Ecosystem Management Project was completed, some of the amendments evolved into long-term direction when the decision was made to limit the Interior Columbia Basin effort to scientific reference rather than management direction. Direction regarding the amendments related to the Interior Columbia Basin science placed constraints on management activities by limiting removal of trees that were 21 inches diameter or larger and allowing limited situations where harvest in late and old structure stands may occur. PACFISH and INFISH defined stream buffers referred to as riparian habitat conservation areas, and further limited management activities that could occur within them.

Project-specific amendments to the Forest Plans were also plentiful. Some applied to standards, guidelines, and management area boundaries to account for unexpected conditions, such as those created by wildland fire (any non-structure fire that occurs in the wildland). Others allowed for adjustments in response to unexpected projects, such as land exchanges. As time elapsed, it became evident that the Eastside Screens, PACFISH, and INFISH directives needed to be updated into long-term direction, as some projects necessitated specific amendments to this Forestwide interim amendment to meet project objectives. Those amendments permitted activities that allowed limited removal of trees 21 inches diameter or larger, selected harvest in late- and old-structure stands, and vegetation manipulation in riparian habitat conservation areas.

Working Collaboratively with Our Stakeholders to Achieve Sustainable Forest Management Direction

Since the Forest Service began revising the Blue Mountains Forest Plans in 2003, there has been an increasing effort in the Forest Service to work collaboratively with the public, organizations, and various Tribal and government entities. What we heard from the combined voices providing input to the Blue Mountains Forest Plan Revision is similar to what national Forest Service leadership has been saying as well—that we need to hold discussions and listen to our stakeholders about managing the national forests sustainably, in a way that protects valuable resources while also providing goods and services.

The collaboration that has taken place for this plan revision effort has included entities such as Tribes, government agencies, counties, other interested parties (such as permittees and recreation groups), and the Forest Service. Dialogue has required being able to consider and integrate

[8] The Eastside Screens are regional standards for riparian areas, ecosystems, and wildlife that amended forest plans for national forests on the east side of the Cascade Mountains in 1994. A slightly revised version of this amendment was issued in 1995. For more information, see the Eastside Screens Chronology at: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3794796.pdf

varying interests, desires, and concerns between the different groups and collaboration has been focused around concepts stated in public comment letters where requests were made to:

- Increase the amount of goods and services people can receive from the Malheur, Umatilla, and Wallowa-Whitman National Forests (socioeconomic benefits);
- Strengthen forest resiliency to withstand potential disturbance from insects, diseases, and wildfire; and
- Enhance vegetative and riparian habitat across National Forest System lands, such that wildlife is more attracted to the Blue Mountains national forests.

As a result of this input, we have developed two additional alternatives that address these concerns and interests: Alternative E-Modified and Alternative E-Modified Departure. See Chapter 2 for detailed descriptions of these alternatives.

Purpose and Need

The purpose and need in this Final Environmental Impact Statement is unchanged from what was stated in the Draft Environmental Impact Statement published in 2014. Economic, social, and ecological conditions have changed since the 1990 Forest Plans were developed. The Malheur, Umatilla, and Wallowa-Whitman National Forests are revising their 1990 Forest Plans to:

- Meet the requirements of the National Forest Management Act of 1976;
- Address changed conditions and provide consistent management direction (as appropriate) across the three National Forests;
- Incorporate changes in law, regulation, and policy; and
- Use best available scientific information.

In particular, the Blue Mountains Planning Team addressed the following purposes in the revised Forest Plans:

1. To more adequately protect and restore terrestrial plant and animal species and their habitats, as recommended in relative and pertinent direction.

Two objectives specifically stated in the 2015 – 2020 Strategic Plan for the Forest Service under Strategic Objective A, whereby the long-term goal is that the Nation's forests and grasslands are in a healthy ecological condition, which are:

> (1) Develop and apply detection, prediction, prevention, mitigation, treatment, restoration, and climate adaptation methods, technologies, and strategies for addressing disturbances such as wildfire, human uses, invasive species, insects, extreme weather events (e.g., storms), and changing climatic conditions, and
>
> (2) Coordinate inventory, monitoring, and assessment activities across all lands to improve our adaptive management of natural resources.

The Columbia Basin Strategy (2000) identifies key elements to be addressed in planning efforts, such as source habitats, that are not addressed in the 1990 Forest Plans. Additionally, the structural arrangement of vegetation, both vertical and horizontal, and the size and arrangement of trees, grasses, and shrubs are important components of wildlife habitat. Many changes to forest stand structure have occurred due to disturbances such as fire, timber harvest, and insects and diseases. There has been a loss of large (20 inches diameter and greater) and medium (15 to 20

inches diameter) trees across the landscape. Within the dry upland forest, where some of the most significant changes in forested structural stages have occurred, the amount of old forest single story has been greatly reduced from pre-1900 levels. All of the changes have led to reductions in habitat for some species and increases for others. The 1990 Forest Plans need to be updated to reflect current science relating to plant and animal species and their habitats.

2. To more adequately protect and restore watersheds and aquatic habitats.

The Columbia Basin Strategy (2000) emphasizes restoring the processes responsible for creating and maintaining aquatic and riparian habitats and restoring naturally functioning riparian ecosystems. It also outlines specific components to be included in revised forest plans. The 1990 Forest Plans include, by amendment, interim direction (such as PACFISH, INFISH, and the Eastside Screens) for management of threatened or endangered fish species. However, the 1990 Plan language was never changed to integrate this interim direction or resolve conflicts between the existing plan language and the interim direction language. The 1990 amended Forest Plans do not adequately provide integrated management strategies for maintenance and restoration of properly functioning watersheds that provide a range of benefits on and off the Blue Mountains national forests. These include, but are not limited to, providing habitat for terrestrial, aquatic, and riparian-dependent species; maintaining water quality; providing channel stability; reducing erosion; moderating floods; and maintaining reliable stream flows for downstream users.

3. To address management of fuels and fire risk.

Changing vegetative conditions have made forests more susceptible to disturbances, such as uncharacteristically severe fires, and insects and diseases. Several factors have contributed to the changes, including the cumulative effects of periodic and sometimes extended drought, climate change, increasing vegetative density, shifts in forest species composition, and modified landscape patterns. Forested areas on the Blue Mountains national forests are dominated by dense, multi-storied conifer stands with tree species composition that are not resilient to existing and expected conditions. The 1990 Forest Plan standards and guidelines do not adequately address the multiple factors that have created the existing uncharacteristic conditions nor do they adequately address the varied nature of the landscape. They also do not address the need for management strategies that recognize the unique qualities of various landscapes. An integrated strategy that recognizes multiple risk factors and addresses variability in conditions and site potentials is needed.

4. To address climate change.

The 1990 Forest Plans do not address climate change. Climate change is expected to impact plant species range and composition and alter competitive relationships between plant species. Changes in the composition and structure of plant communities will, in turn, alter the character and distribution of wildlife habitats. Future conditions may be more favorable to some undesired nonnative plant and animal species. The full extent of changes in response to climate change on natural resources in the Blue Mountains is uncertain, but integrated management direction is needed to maintain or increase the resilience of the National Forests in the face of these changes.

5. To recognize the interdependency of social and economic components with national forest management.

The relationship between the Malheur, Umatilla, and Wallowa-Whitman National Forests and the people who live, work, and play in them is not adequately recognized in the 1990 Forest Plans. National forests provide a variety of opportunities: recreation, work, and to exercise cultural and spiritual traditions. Local communities provide infrastructure that contributes to the ability of the

national forests to restore and maintain ecological systems. In eastern Oregon, the tie between national forest management and the economic and social well-being of local public is particularly important for the communities near the Blue Mountains national forests. With high unemployment rates and many small communities inadequately positioned to attract new industries, providing opportunities related to goods and services that are associated with forest products could help to improve social and economic conditions. In addition, many actions needed to improve forest structure, reduce fuel loading, and conduct other restoration activities in eastern Oregon and Washington are closely related to community involvement through local workforce and infrastructure.

Decisions to be Made

The authorized decisionmaker for the three records of decision is the Regional Forester for the Pacific Northwest Region.

Planning for units of the National Forest System involves two levels of decisionmaking. The first level of planning involves the development of a programmatic land management plan (forest plan) that provides direction for integrated resource management and for guiding project and activity decisionmaking on the planning unit. Forest plans set out forestwide and management area direction with standards and guidelines for future decision-making and are adjustable through amendment and revision. Forest Plan management area and forestwide direction are the “zoning ordinances” under which future decisions are made. Forest plan approval establishes multiple-use goals, desired conditions, and objectives for the planning unit. Forest Plan-level actions are approval, amendment, and revision (16 USC 1604(d) and (j), 1604(f)(4), and 1604(f)(5)).

Forest Plan approval results in the following:

- Establishment of desired conditions, forest multiple-use goals and objectives (1982 Rule Provision 36 CFR 219.11(b))
- Establishment of standards and guidelines applying to future activities (1982 Rule Provision 36 CFR 219.11(c))
- Establishment of management areas and management area direction applying to future activities in that management area, including the suitability of lands for resource management (16 USC 1606(g)(2)(A) and 1982 Rule Provision 36 CFR 219.11(c))
- Designation of suitable timber production land (16 USC 1604(k) and 1982 Rule Provision 36 CFR 219.14) and establishment of the allowable timber sale quantity (16 USC 1611 and 1982 Rule Provision 36 CFR 219.16)
- Recommendation to Congress of areas eligible for wilderness designation as required (36 CFR 219.17) and rivers eligible for inclusion in the National Wild and Scenic Rivers System as required (16 USC 1271-1287, 36 CFR 297, and 47 FR 39454). For the Wallowa-Whitman National Forest, Forest Plan approval would complete the two wild and scenic rivers suitability analyses.
- Establishment of monitoring and evaluation requirements (2012 Rule Provision 36 CFR 219.12.

The Plan Area for each of the three National Forests are the lands within each National Forest's administrative boundaries (36 CFR 219.2 (b):

- The Malheur National Forest Plan Area includes lands within its administrative boundary. In 2001, the Burns Ranger District of the Malheur National Forest and the Snow Mountain Ranger District of the Ochoco National Forest were consolidated. The new Ranger District was named the Emigrant Creek Ranger District and is administratively attached to the Malheur National Forest.
- Umatilla National Forest Plan Area includes lands within its administrative boundary.
- Wallowa-Whitman National Forest Plan Area includes lands within its administrative boundary. This boundary includes portions of the Nez Perce-Clearwater and Payette National Forests that are contained within the Hells Canyon National Recreation Area. Although the national recreation area is included within the Wallowa-Whitman National Forest administrative boundary, this area is not included in the analysis presented in this Final Environmental Impact Statement (see discussion below under "Relationships to Other Assessments" section).

Programmatic forest plans do not authorize or implement any specific actions. Actions requiring specific decisions will require separate Forest or project level National Environmental Policy Act analysis. This second level of planning involves the analysis and implementation of management practices designed to achieve the goals, desired conditions, and objectives of a specific forest plan. Individual projects and activities within the framework of a specific forest plan are proposed and analyzed under the National Environmental Policy Act (1969) requirements for decision-making; however, they will be implemented at the ranger district or a specific site-project level.

Decision Criteria

Decision criteria were identified by each Forest Supervisor from the three National Forests and approved by the Pacific Northwest Region Regional Forester. These criteria were used to evaluate the alternatives and determine which alternative was ultimately selected:

- Meeting all applicable laws and regulations and alignment with Forest Service policy.
- Determining the balance between meeting the purpose and need with addressing the substantive issues raised during the environmental analysis process.
- Providing a mix of benefits to address the needs for change by:
    - ♦ Leading to more resilient and sustainable terrestrial ecosystems.
    - ♦ Accelerating improvement of watershed, aquatic, and riparian conditions.
    - ♦ Restoring and maintaining scenery, cultural and recreation resources, treaty resources, and wildland-urban interface areas.
- Minimizing conflicts between revised forest plans and required travel management decisions.
- Maintaining or enhancing biological diversity and the long-term health of the national forests.
- Contributing to economic and social needs of people, cultures, and communities.

Environmental and Regulatory Compliance

Over time, a framework of laws, regulation, and guiding legislation that works to guide the management of National Forest System lands has been enacted. Legal mandates governing national forest management date back to the Organic Act of 1897, which provided that national forests would be managed for the dual purpose of protecting water flows and providing a continuous supply of timber for the American public.

This Final Environmental Impact Statement was prepared in compliance with relevant Federal and State laws and regulations (see Volume 4, Appendix B). Laws, regulations, and other written directives are either cited in this document with references available, or were considered as stated in Appendix B. Additional direction for managing National Forest System lands comes from a variety of sources, including executive orders, the Code of Federal Regulations, and the Forest Service directives system, which includes the Forest Service Manual and the Forest Service Handbook. This management direction is generally not repeated in the Forest Plans. This section highlights the key laws that guide forest planning.

The Multiple Use-Sustained Yield Act (1960) provides for the sustainability of the multiple uses of natural resources in ways that best meet the needs of the public while maintaining the long-term productivity of the land for multiple uses and in such a manner that these lands are available to future generations. The magnitude and intensity of any effects are disclosed to the public, and the public has the opportunity to comment on the actions proposed.

The National Forest Management Act (1976) and its accompanying legislation guides the creation, revision, and amendment of National Forest Land Management Plans, and the Forest and Rangeland Renewal Resources Planning Act (1974) directs that the suitability of lands for resource management be identified and a process for the revision of land and resource management plans established. This revision process was conducted under the legal framework of the National Forest Management Act, and the provisions of the 1982 Planning Rule, as allowed by the 2012 Planning Rule language (36 CFR 219.7(b)(3)). The National Forest Management Act requires forest plans to be revised at least every 10 to 15 years or sooner if warranted by changed conditions. The multiple-use desired conditions and objectives, design criteria (standards and guidelines), and monitoring all work together to define management direction for the three Blue Mountains national forests. However, successful implementation of the management direction and the rate of accomplishment of desired conditions are dependent upon the congressional budget process and other factors.

The National Environmental Policy Act (1969) requires that all major Federal actions significantly affecting the human environment be analyzed, and the consequences to the quality of the human environment from proposed management actions are to be considered. The regulations implementing the Act further require that agencies prepare environmental impact statements concurrent and integrated with environmental analysis and related surveys and studies required by such laws as the Endangered Species Act of 1973, the National Historic Preservation Act of 1966, the Wilderness Act of 1964, and the Wild and Scenic Rivers Act of 1968. Other environmental review laws and executive orders, such as the Clean Air Act of 1977 and the Clean Water Act of 1948 are also considered.

The three revised Forest Plans will continue to honor American Indian reserved rights through consultation and coordination, and each National Forest will maintain a government-to-government relationship with federally recognized Tribal Governments.

Other Guidance and Direction

Other guidance (such as comprehensive river or wilderness management plans) are being brought forward where applicable, for each of the three National Forests, to ensure that necessary guidance and direction is provided to continue protecting and preserving lands for current populations of people and animals now, as well as into the future, as the mission of the Forest Service states.

Relationship to Other Assessments

There are broad-scale assessments in place that affect management decisions for the Blue Mountains national forests. These assessments are referenced in this chapter to explain the revision process in the context of these larger analyses. National Forest System lands within the Blue Mountains Plan Area were considered along with other Federal, Tribal, State, and private lands to the extent possible for all resources.

National Scale

The Department of Energy, Bureau of Land Management (BLM, Department of the Interior), the Forest Service (Department of Agriculture), and Department of Defense issued a Final Programmatic Environmental Impact Statement that documents the evaluation of issues and impacts associated with the "Designation of Energy Corridors on Federal Land in 11 Western States" (DOE/EIS-0386) (DOE and BLM 2008). Based on the findings of that document, no energy corridors were identified on national forest lands within the Blue Mountains national forests.

Regional Scale

The Interior Columbia Basin Ecosystem Management Project responds to presidential direction in 1993 to develop a scientifically sound, ecosystem-based strategy for management of 64 million acres of lands administered by the Forest Service and the BLM within the Columbia River Basin and portions of the Klamath and Great Basins in Oregon. Interior Columbia Basin analysis also responds to concerns about forest and rangeland health, uncharacteristically intense wildland fires, threats to certain fish and wildlife species, and concerns about local community economic and social well-being. In addition, there was little broad-scale scientific knowledge of the ecological, biophysical, social, and economic conditions, trends, risks, and opportunities within the Plan Area.

The Eastside Ecosystem Management Project Charter was the catalyst for the Interior Columbia Basin Ecosystem Management Project in January 1994. The charter, signed by the Chief of the Forest Service and the Director of the BLM, directed the agencies to develop and adopt a scientifically sound, ecosystem-based strategy for managing all Forest Service and BLM-administered lands within the basins. A scientific assessment of the basins provides a better understanding of the scope and possible broad-scale causes of current resource conditions. The scientific findings formed the basis for management strategies evaluated for the Interior Columbia Basin Ecosystem Management Project.

A final environmental impact statement and proposed decision were published in December 2000. Rather than prepare a record of decision, in 2002 the BLM state directors and Forest Service regional foresters chose to incorporate the Interior Columbia Basin's scientific data and resource information into land and resource management plans and project implementation (Forest Service

Agreement No. 03-RMU-11046000-007). On April 18, 2014 deputy executives of the Forest Service, BLM, NOAA Fisheries, Fish and Wildlife Service, and the EPA issued a memo ("Updated Interior Columbia Basin Strategy") providing further guidance to apply the knowledge gained by the Interior Columbia Basin Ecosystem Management Project to the revision of land use plans.

The Pacific Northwest Region of the Forest Service has continued to comply with the guidance noted above through the development of documents since then which have included:

- the 2005 Regional Aquatic Restoration Strategy (hereafter, the "2005 Regional ARS")
- the 2008 Regional Aquatic and Riparian Conservation Strategy (hereafter, the "2008 Regional ARCS")
- the 2016 Regional Aquatic and Riparian Conservation Strategy (hereafter, the "2016 Regional ARCS"), and
- the 2018 Blue Mountains Aquatic and Riparian Conservation Strategy (hereafter, the "2018 Blue Mountains ARCS").

Each of these documents, when they were originally developed and with their revision(s), have been intended to move the Forest Service towards an integrated strategy to be consistent with the aquatic components of the Updated Interior Columbia Basin Strategy. For example, one main difference between the 2008 and the 2016 Regional ARCS documents is that the 2016 Regional ARCS acknowledges and includes the Watershed Condition Framework developed by the Forest Service in May 2011. The Watershed Condition Framework establishes a new consistent, comparable, and credible process for improving the health of watersheds on national forests and grasslands. More about the Watershed Condition Framework can be found at the following link: https://www.fs.fed.us/biology/watershed/condition_framework.html.

The 2018 Blue Mountains ARCS integrates information from many of the aforementioned documents so that appropriate regional guidance relative to the Plan Area is brought forward for the Revised Forest Plans.

Forestwide Scale

Analysis of the Management Situation

An "Analysis of the Management Situation" was completed for the Blue Mountains national forests in 2005. The analysis summarizes information about the conditions of the land and peoples' uses and values associated with it. This provides the foundation for developing a proposal for future management of the Blue Mountains national forests. It captures a snapshot in time of the current social, ecological, and economic setting and helps define the decision space for that time. It identifies where and why there is a need to change the 1990 Forest Plans and what needs to be addressed in this revision.

The Analysis of the Management Situation is not a decision document. It was prepared in accordance with the requirements of the 1982 Planning Rule provisions (36 CFR 219(e)). It documents the current management situation, conditions, and trends with regard to the components of the 1990 Forest Plans and it identifies any need for change in those plan components.

Oil, Gas, and Geothermal Leasing

A potential natural gas resource occurs in Mesozoic age rocks beneath the Malheur and Umatilla National Forests. As required by Forest Service regulations, an analysis was completed in 1997 that identified lands administratively available for oil and natural gas leasing within the Malheur and Umatilla National Forests. This decision is incorporated into the existing Forest Plans by amendment. Lands excluded from the analysis include lands withdrawn from mineral entry or leasing. Wilderness areas, recommended wilderness areas, and wilderness study areas are legally unavailable for leasing. Those parts of the Snake River basin within the Umatilla National Forest and congressionally designated areas of the National Forests are also unavailable. All other lands within these National Forests are considered administratively available for oil and gas leasing, subject to one or more of four basic lease stipulations: 1) no surface occupancy, 2) seasonal use, 3) controlled surface use, or 4) standard lease stipulations. The 1997 leasing decision will be carried forward into the revised plans for the Malheur and Umatilla National Forests. When specific lands are proposed for lease, the Forest Service would comply with all applicable direction, as well as review the existing leasing decision where appropriate to ensure adequacy of compliance with the National Environmental Policy Act, consistency with the Forest Plan, and proper application of lease stipulations.

Geothermal Leasing – Subtitle B of the 2005 Energy Policy Act section 222 amends section 4 of the Geothermal Steam Act of 1970(d) and states: "All future forest plans and resource management plans for areas with high geothermal resource potential shall consider geothermal leasing and development." Figure 2 shows that geothermal energy development is already present on and adjacent to the Blue Mountains national forests.

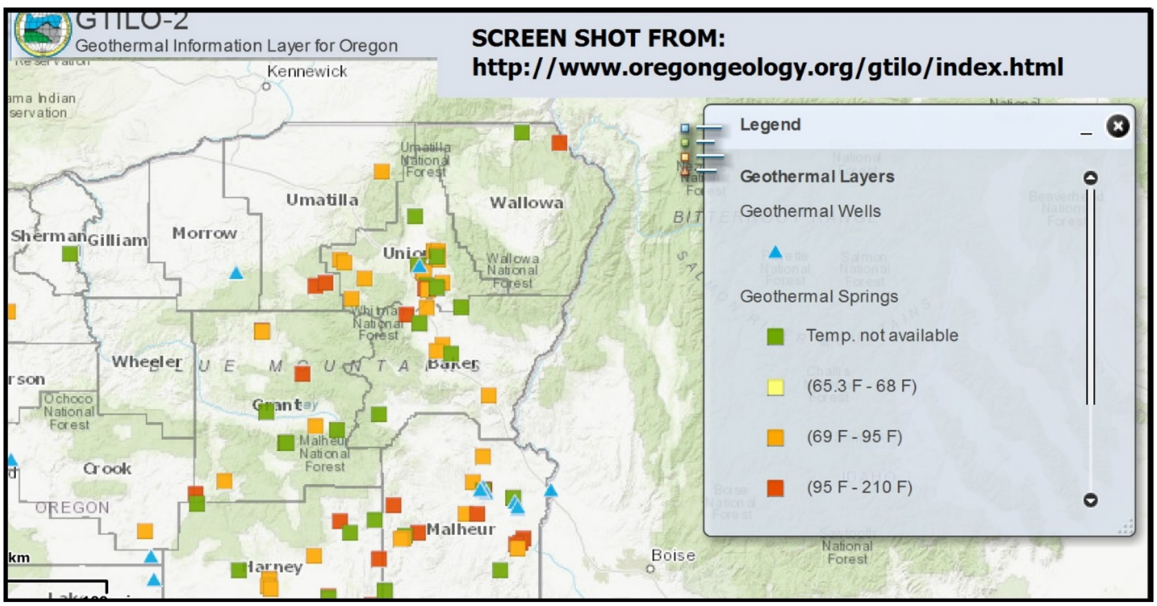


Figure 2. Screen shot from Oregon Geology showing geothermal activity in the Blue Mountains national forests as of November 19, 2017

Hells Canyon National Recreation Area Comprehensive Management Plan

The law establishing the Hells Canyon National Recreation Area (Public Law 94-199) required that a separate management plan be developed for the National Recreation Area. The Hells Canyon National Recreation Area Comprehensive Management Plan was developed and

approved on April 30, 1982. When the 1990 Forest Plan for the Wallowa-Whitman National Forest was approved, this Comprehensive Management Plan was incorporated into the Plan without amendment under the provisions of the 1982 Planning Rule (1982 rule provision 36 CFR 219.2(b)), which states:

> . . . (if), in a particular case, special area authorities require the preparation of a separate special area plan, the direction of any such plan may be incorporated without modification in plans prepared under (these regulations).

In 2003, the Comprehensive Management Plan was revised and, by amendment, became part of the 1990 Forest Plan for the Wallowa-Whitman National Forest. The 2003 Hells Canyon National Recreation Area Comprehensive Management Plan is being incorporated, without modification (per 219.2(b) of the 1982 Planning Rule), and would continue to be a part of the revised Forest Plan for the Wallowa-Whitman National Forest. The 662,000-acre national recreation area includes about 30,000 acres of lands that are not part of the National Forest System. The area is managed via its own enabling legislation and the Comprehensive Management Plan Record of Decision (USDA Forest Service 2003).

The plan revision interdisciplinary team in place during 2004 reviewed the Comprehensive Management Plan to determine if there was a need for change to revise that plan. The Analysis of the Management Situation (reflected in the 2004 Current Management Situation) for the Hells Canyon National Recreation Area showed there was no need for change in this area of the Wallowa-Whitman National Forest.

The 4.9 million-acre project area for the Blue Mountains national forests referred to throughout this Final Environmental Impact Statement excludes the (662,000-acre) Hells Canyon National Recreation Area. A cumulative effects analysis to incorporate the 2003 Comprehensive Management Plan unchanged into the Wallowa-Whitman National Forest Revised Plan is provided in Chapter 3.

Wilderness, Wild and Scenic River and Other Plans

Some amendments to the 1990 Forest Plans and other resource management decisions resulted in the creation of management and activity plans for specific designated management areas. These would be carried forward in this revision effort unchanged. These plans are currently tiered to the 1990 Forest Plan, but once the Revised Forest Plan decision is in place, those Plans would tier to the new Revised Plans. These plans include wilderness plans, wild and scenic river plans, research natural area plans, and so forth. The one exception to this is the Hells Canyon Wilderness Area Plan, which would continue to be tiered to the Comprehensive Management Plan attached to the Revised Wallowa-Whitman Forest Plan, for the reasons previously discussed. These various plans continue to be effective at maintaining, enhancing, and protecting the specific designated management areas. In this planning effort, the three National Forests brought forward many of the plan components that were in the individual plans. Unless specifically identified in the Revised Forest Plan, the actions of these management plans would continue to be used for the future management of these specific designated management areas.

Travel Management Planning

Travel management decisions are made at the project level; they are site-specific decisions that are not typically made in Forest Plans (which are programmatic documents). Travel analysis[9]

[9] 36 CFR 212.51(a)

provides a bridge between the strategic guidance in Forest Plans and travel management decisions made at the project level. In December 2005, the Forest Service issued a regulation known as the Travel Management Rule.[10] The Travel Management Rule clarifies current Forest Service policy regarding motor-vehicle use and provides management direction that allows sustainable access by motor vehicles, including off-highway vehicles, on national forests and grasslands. The Travel Management Rule requires each national forest and grassland that does not have a designated motorized travel system to establish one and for that system to be documented on a publicly available motor vehicle use map that will be updated annually. Designations to motorized travel systems may include the limited use of motor vehicles within a specified distance (corridor) of certain designated National Forest System roads solely for dispersed camping or big game retrieval.[11]

Once a motor vehicle use map is published, all motor-vehicle travel that is inconsistent with its designations is prohibited.[12] With the exception of wilderness areas, the Forest Plans for the 1990 Wallowa-Whitman and Malheur National Forests include little management direction to distinguish motor vehicle use allocations from nonmotorized use allocations; however, the Forest Plan for the Umatilla National Forest included detailed management direction related to motor vehicle use. Subsequent to the Umatilla National Forest 1990 Forest Plan decision, each ranger district on the Umatilla National Forest made access and travel management decisions (USDA Forest Service 1992a, 1992b, 1993a and 1993b), leading to the production of a forest-wide motor vehicle use map in compliance with the Travel Management Rule.[13] After the revised plans for the Malheur and Wallowa-Whitman National Forests are in place, those forests will commence with their subpart B travel management planning.

In 2005, the agency regulated winter motorized use as a discretionary activity under its regulations for Use by Over-Snow Vehicles. Consistent with a court order dated March 29, 2013, the United States Department of Agriculture (the Department) amended the Department's Travel Management Rule to require designation of roads, trails, and areas on National Forest System lands to provide for over-snow vehicle use. These requirements are outlined under Subpart C of the travel management rule.

Allotment Management Plans

A forest plan provides guidance for the rangeland resource and livestock grazing program. Project-level decisions comply with standards, guidelines, and desired conditions, and determine livestock numbers and pasture rotations that apply to a specific allotment. That decision is captured in each allotment management plan, which is incorporated into the term grazing permit as part of the management direction for an allotment. Annual operating instructions are issued to identify changes to an allotment management including pasture rotation, season or livestock numbers, and range betterment projects for a given year. Current allotment management plans are tiered to the 1990 Forest Plan. Once revised Forest Plan decisions are implemented, the three National Forests will incorporate the new management direction as a modification to the term grazing permits for each allotment on the National Forests, as well as in each allotment’s annual operating instructions until new allotment management plan environmental analysis can be conducted for each allotment.

[10] 36 CFR parts 212, 251, 261, and 295
[11] 36 CFR 212.51(b)
[12] 36 CFR 261.13
[13] 36 CFR 212.51, subpart B and 36 CFR 216.13

Landscape Scale

Several watershed assessments at the subbasin or watershed scale have been completed since the 1990 Forest Plans were completed. Subbasin plans were developed collaboratively by state and Federal fish and wildlife agencies, American Indian Tribes, local planning groups, and fish recovery boards. The planning effort was guided by the Northwest Power and Conservation Council and funded by the Bonneville Power Administration. Subbasin plans identify priority restoration and protection strategies for habitat and fish and wildlife populations in the U.S. portion of the Columbia River system. The plans will guide the future implementation of the council's Columbia River Basin Fish and Wildlife Program, which grants portions of Bonneville Power Administration electricity revenues to protect, mitigate, and enhance fish and wildlife affected by hydropower dams. Subbasin plans will provide this guidance by providing the context for proposed project review for funding through the council's program. Subbasin plans were finalized in 2005 for all subbasins within the Plan Area except for Silver Creek and Silvies River within the Malheur National Forest. The completed subbasin plans are available at the Northwest Power and Conservation Council website.[14]

Watershed assessments at the 5th-field hydrologic unit code watershed scale have also been completed since 1990. Watershed analysis within the Blue Mountains has been completed on 3.6 million of 5.5 million (83 percent) of the administered acres. Umatilla National Forest watersheds with completed reports are available on the Umatilla National Forest website[15] under "Land and Resources Management Planning." Watershed assessments for the Wallowa-Whitman and Malheur National Forests are available in the planning record.

Public Involvement

Prior to Release of the Draft Environmental Impact Statement – Public involvement efforts for the Blue Mountains Forest Plan Revision started in 2004 with community and cooperator meetings, field trips, workshops, open houses, and information distributed through a variety of methods. A notice of intent to prepare the Draft Environmental Impact Statement for the proposed revised plans was published in the Federal Register on March 29, 2010 (FR, Vol. 75, No. 59). The notice asked for written public comment on the proposal by May 25, 2010. This is what is referred to as the "scoping comment period." During the scoping comment period, the planning team also held additional public meetings in several locations in Oregon and Washington. In response to the request for comment, we received 4,174 total responses, which included 110 unique comment letters and 4,025 organized form letters. Details and analysis of the scoping period comments are available in the planning record. Following the scoping period, the Forest Service held alternative-development meetings with a variety of organizations: advisory committees, collaborative groups, counties, industry representatives, and interest groups.

After the Release of the Draft Environmental Impact Statement – In February 2014 the Forest Service published the Blue Mountains Proposed Revised Land Management Plan (Draft Forest Plan) and Draft Environmental Impact Statement. We received more than 1,100 letters on the Draft Forest Plan and Draft Environmental Impact Statement from the public, and we identified more than 4,300 comments. Responses to comments categorized by concern statements are available in Volume 4, Appendix C of this document.

[14] http://www.nwcouncil.org/fw/subbasinplanning/home/

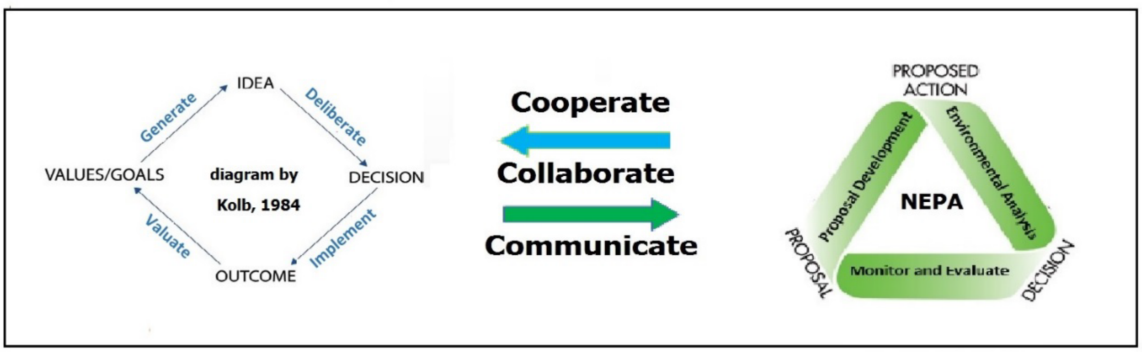
[15] http://www.fs.usda.gov/detail/umatilla/landmanagement/planning/?cid=fsbdev7_016111

From March through June 2014, the Blue Mountains national forests hosted 14 public meetings and a webinar to provide information about the documents, explain the formal public comment process, answer questions, and listen to public input.

Beginning in 2015, there began an inclusive and expanded public "reengagement" process where another 20 formal public listening sessions followed the release of the Draft Environmental Impact Statement up through 2016 to allow the public even more time to share their concerns. Some of the outreach included generating radio talk sessions where information was made available to call-in listeners, newsletters mailed out to those that have provided the Forest Service with their address so they could receive updates regarding the Forest Plan Revision process, and other stakeholders in meetings for entities such as state agencies, county commissioners, and Tribal representatives.

With regard to working with states, counties, and Tribal representatives, the Forest Service used the iterative National Environmental Policy Act (NEPA) process (Clement et al. 2014, see figure below). In the iterative NEPA process, the interdisciplinary team worked under management direction from regional and national agency leaders to develop two additional alternatives. Generally, leading up to and following the public comment period there was excellent consultation, coordination, and collaboration between the Forest Service and those that elected to be participating stakeholders and cooperating agencies.

Using the Iterative NEPA (iNEPA) process to increase transparency, accountability, and awareness for the Blue Mountains Forest Plans Revision and the Environmental Impact Statement.



Iterative NEPA: The intent is to use environmental information from multiple parties during the environmental analysis process rather than only at distinct comment periods for a draft and final impact statement. This provides efficient and effective use of an analysis to improve agency decisionmaking. Stakeholders are invited to regularly discuss issues, differences and agreements, and necessary environmental, social, and economic analyses while alternatives are explored, evaluated, and modified throughout the process. The intent is to focus on a deliberative public process and appropriate disclosure to promote the National Environmental Policy Act's purposes.

As shown in the diagram above, two deliberation processes are used together when deliberating with stakeholders. The first process (on the left) displays a generic decision-making model (Kolb 1984). On the right is a planning triangle used by the Forest Service for nearly three decades. Together the processes can be used to "begin with the end in mind" for stakeholders and the Forest Service," consider what the stakeholders interests are, as well as to acknowledge what is feasible for the Forest Service and necessary by NEPA.

The planning record contains details of the collaborative approach and the iterative NEPA process used in the final development of this Final Environmental Impact Statement.

The following issues were derived from all public comments received before and after the release of the Draft Environmental Impact Statement. See Volume 3, Chapter 4 for more information on public involvement, and consultation and coordination with governmental and Tribal entities that has occurred during this Forest Plan Revision effort.

Issues and Key Indicators

Issues (cause-effect relationships) serve to highlight effects or unintended consequences that may result from the proposed action. Issues provide opportunities during the analysis to explore alternative ways to meet the purpose and need for the proposal while reducing adverse effects. To address concerns brought forward during the scoping and Draft Environmental Impact Statement comment processes, the interdisciplinary team formulated alternatives, prescribed mitigation measures, or analyzed additional environmental effects that were not previously identified. At the forest-wide planning level, mitigation measures are incorporated into management direction (goals and objectives, desired conditions, standards and guidelines) or management prescriptions that influence the type, amount, and intensity of management actions that implement the Forest Plan or covered by laws, rules and regulations not addressed in the Forest Plan. The issues were developed to respond to concerns with the proposed action that was distributed for public review in 2010 and the alternatives that were identified in the Draft Environmental Impact Statement that was released in 2014. The responsible official selected issues for revision based on one or more of the following criteria:

- Would these issues be used to help develop management alternatives or management direction or would they be used in the allocation of management prescriptions?
- Would management alternatives, direction, or prescriptions have discernible effects on the issues or related resources?
- Would effects raised by the issues be sufficiently different by alternative to provide the responsible official with rationale for choosing a preferred or selected alternative?

Six issues of concern remain in this Final Environmental Impact Statement. Each issue is explained differently from the Draft Environmental Impact Statement to describe the public perception of each issue in 2010, as compared to how comments on that issue were received following the 2014 Draft Environmental Impact Statement. A summary statement is provided for each issue that describes how the Final Environmental Impact Statement addresses each issue, including the key indicators that are used in the analysis of alternatives. Key indicators are measureable indicators of change linked to significant issues. Indicators associated with each issue have a cause-and-effect relationship and reveal how the alternatives address the issues. In Chapter 2, a tabular comparison of the issues and indicators, by Forest, is presented to show how each alternative addresses the issues and indicators.

Issue 1: Access

The Revised Forest Plans will not make a final determination for roads that would remain open or be closed on any of the three National Forests. Such decisions are made through a travel management process for each national forest. The Travel Management Plan for the Umatilla National Forest has been completed. The Travel Management Plan process for the Malheur and

the Wallowa-Whitman National Forests are expected to commence after the records of decisions for the Revised Forest Plans have been signed.

2010 Pre-Draft Environmental Impact Statement Scoping Concern Statement: Some people suggested allocating additional areas to undeveloped backcountry to satisfy needs, such as solitude and nonmotorized recreation, while others requested that additional areas be designated to allow motor vehicle recreation and requested that what is currently available not be reduced.

2014 Comments on the Draft Environmental Impact Statement: Comments received by the public requested that: (1) no roads be closed, and conversely, that (2) roads be closed.

Closing forest roads to motorized use creates a hardship for low income families that depend on motorized access to National Forest System lands for hunting, berry picking, harvesting mushrooms, and wood collecting, among other uses. In addition, less mobile national forest visitors, recreationists, and elderly users who depend upon access to the National Forests to enjoy their benefits would be more restricted in the areas they could access.

The main reason for the public asking that some roads be closed is due to noise generated by recreational vehicles in areas near wilderness, where solitude is desired. The secondary reason stated is that multiple-use conflict is growing in some areas, such as areas where users collect berries and mushrooms, and in popular areas where different user groups desire to use the same area but for different pursuits. There is also concern raised by the public for areas where motorized use is one of the factors associated with degradation of some natural resources.

Statement: While the Revised Forest Plans will not change designations of roads or trails for motor vehicle use, they will provide direction for future planning of motor vehicle routes and areas. The Revised Forest Plans include plan components, specifically suitability ratings for management areas that identify where motor vehicle use is identified as either suitable or unsuitable, and where road and trail construction is rated suitable or unsuitable for each management area. These plan components and suitability ratings, along with the recently completed Travel Analysis Reports for Malheur, Umatilla, and Wallowa-Whitman National Forests, will help inform future project-level decisionmaking regarding each National Forest's transportation system. Motor vehicles are used for hunting and fishing, summer and winter recreation, private land access, management activities, and fire suppression, among other uses. The number of acres suitable for motor vehicle use and the desired conditions for open motor vehicle route density will influence the future transportation system and future road closure or development opportunities. These acres are an important factor affecting the health of terrestrial, aquatic, and riparian habitats.

Key Indicators:

- Road maintenance funds projected to be available to maintain the transportation system
    - Projected road maintenance for each road maintenance level (miles)
- National Forest System lands that would be suitable for motor vehicle route and area designation and use or suitable only for nonmotorized use (acres)
    - Acres suitable for summer motor vehicle use.
    - Acres suitable only for nonmotorized summer use
    - Acres suitable for winter over-the-snow motor vehicle use

Issue 2: Economic and Social Well-being

2010 Pre-Draft Environmental Impact Statement Scoping Concern Statement: Many people stressed the importance of economic and social contributions of the Blue Mountains national forests to the surrounding communities, counties, and American Indian Tribes. One concern was the importance of maintaining the infrastructure in local communities (such as mills, roads, equipment) and a skilled local workforce so that the Forest Service could draw upon that infrastructure and local workforce to accomplish restoration goals as well as contribute to the economic and social well-being of communities. Another concern was the potential effects of large disturbances, such as insects and diseases or wildland fire(s), on the economic and social well-being of local communities. Other people stressed ecological values and suggested that a more cautious approach and mix of restoration activities was necessary to protect those ecological values that also contribute to economic and social well-being.

2014 Comments on the Draft Environmental Impact Statement: If the National Forests are not maintained through thinning, planned fire, or other managed activities, goods and services that have the potential to support and improve community well-being may not be available for public use. Stakeholders were concerned about having access in the future on local infrastructure to secure goods and services from the three National Forests. They were also concerned about whether the Forest Service will be able to maintain National Forest System structures (buildings, roads, water facilities, etc.) with budgets being reduced as they have been in the past few years. Wildland fire, insect infestations, and forest diseases were other concerns related to forest health, which is indirectly linked to economic and social well-being.

Statement: Forest Plan direction creates the framework for the range of uses and products and services provided by the National Forests that contribute to the economic and social well-being of local communities, counties, and American Indian Tribes. The quantity and quality of products and services provided by the National Forests contribute to the local economy and the maintenance of local infrastructure. Infrastructure and the local workforce, in turn, play a critical role in the capacity of national forests to conduct forest management activities. The mix of uses, products, and services the Forest Service expects to provide over time will be stated in the Forest Plans.

Key Indicators:

- Number of jobs and amount of labor income associated with Blue Mountains national forests resources and uses
- Timber sale program quantity (TSPQ)

Issue 3: Livestock Grazing and Grazing Land Vegetation

2010 Pre-Draft Environmental Impact Statement Scoping Concern Statement: Several people expressed concern about how revised Forest Plan direction will affect livestock operations and livelihoods, and the potential that further restrictions on allotments would have significant financial and social effects. Other comments were made about the effects of permitted livestock grazing on National Forest System lands and resources, and revolved around riparian area livestock use and its effect on fisheries, biodiversity, and water quality. The potential for disease transmission between domestic sheep and bighorn sheep was also a concern.

2014 Comments on the Draft Environmental Impact Statement: Additional restrictions on grazing allotments (such as managing grazing through stubble height minimums), as well as

potential income loss for ranchers through a possible reduction in animal unit months were a focus of concern for ranchers. Cattle associations, their members, and county commissioners were also concerned about the loss of ranching as a lifestyle. Other concerns stated in comments were related to the impacts of grazing (by all ungulates) on aquatic and riparian habitat, water quality, and biodiversity in the three National Forests' allotment areas. Concern was also noted, especially by Tribes, for the interactions between bighorn sheep, domestic sheep, and pack goats.

Statement: Suitability of areas for livestock grazing (both cattle and sheep) is identified in the revised Forest Plans. Plans also set limitations on activities, including permitted livestock grazing, for the protection of resources. The Forest Plans do not determine the number of permitted livestock or the season, timing, or duration of use. The number of acres suitable for livestock grazing, along with the need to maintain and restore upland and riparian conditions and viable populations of fish and other species, may influence the location and amount of domestic livestock grazing that occurs on the National Forests. Actual decisions regarding permitted livestock grazing will be made at the site-specific project level.

Key Indicators:

- Area suitable for permitted cattle and sheep grazing (acres)
- Estimated cattle and sheep animal unit months
- Rate of progress towards achieving rangeland vegetation desired conditions

Issue 4: Old Forest

2010 Pre-Draft Environmental Impact Statement Scoping Concern Statement: Many people suggested an active approach to reducing the risk of loss from insects, disease, and wildland fire within old-forest stands and accelerating the development of old-forest structure. Other people prefer the use of non-mechanical means to restore old-forest stands and the designation of old-forest management areas.

2014 Comments on the Draft Environmental Impact Statement: Some stakeholders wanted to actively manage old forests using mechanical treatments to improve the forest's resiliency so that it can withstand impacts by insects, diseases, and fire. Others wanted to restore old-forest stands without the use of machines (through the designation of old forest management areas).

Statement: Old forests are unique components of a diverse vegetative community. They are important for their aesthetic qualities, wildlife habitat, carbon storage, ecological importance, and value as commercial products. The 1990 Forest Plans, as amended by the Eastside Screens, place restrictions on harvesting of large trees. The Blue Mountains national forests generally have less old forest than what occurred historically, especially in the dry upland forest, single-story, open canopy stage. The Revised Forest Plans will provide guidance for old forest management on the Blue Mountains national forests in the future to ensure the ecological, social, and economic values they provide.

Key Indicators:

- Acres of old forest within management area allocations with limited management activity
- Acres of estimated timber harvesting within old forest
- Change in old forest structure through time (as expressed by the percentage of old forest in all potential vegetation groups at year 50 and the percentage of the dry upland forest potential vegetation group in the old forest single-story structural stage at year 50.)

Issue 5: Recommended Additions to the National Wilderness Preservation System

2010 Pre-Draft Environmental Impact Statement Scoping Concern Statement: Many people asked that additional areas be proposed for wilderness designation to protect the values that they attach to wilderness areas. Others requested that no additional areas be proposed for wilderness designation because this would prevent them from participating in the activities that they currently enjoy within those areas. Wilderness designation would also limit management activities that could provide economic benefits while reducing the risks of uncharacteristic wildland fire, insect, and disease disturbances.

2014 Comments on the Draft Environmental Impact Statement: Although many commenters requested more acres be added to the National Wilderness Preservation System, several commenters requested just the opposite—that more areas not be recommended as wilderness.

Statement: Wilderness area designation is an allocation of land to a specific use. Proposals are preliminary administrative recommendations that require further review and possible modification by the Chief of the Forest Service, Secretary of Agriculture, and the President of the United States. Congress has reserved the authority to make final decisions on wilderness area designation. The 1990 Forest Plans did not include recommendations for wilderness designation, however the Revised Plans do recommend some additional areas for wilderness designation.

Key Indicator:

- Acres allocated to MA 1B Preliminary Administratively Recommended Wilderness Areas

Issue 6: Ecological Resilience

2010 Pre-Draft Environmental Impact Statement Scoping Concern Statement: There was concern about the type and extent of management activities for restoring ecological resilience that were included in the proposed action. Based on perceptions of current vegetation conditions and resilience, some respondents stated that the proposal was too aggressive, while others stated that the restoration proposal was not aggressive enough.

Public concern is heightened because the management approach to restoring ecological resilience will determine the ecosystem services the Blue Mountains national forests provide.

2014 Comments on the Draft Environmental Impact Statement: Many letters expressed a desire to see the Blue Mountains national forests managed such that they could become more resilient to threats of insects, diseases, and especially wildfire. Suggestions included removing timber in larger increments through harvest quickly (over the next twenty years) and others just wanted to see the pace and scale increased over what was already occurring. Still other commenters made it very clear that their choice for more goods and services to be made available was to improve socio-economics for the local communities.

Statement: Agency policy to reestablish and retain ecological resilience (Forest Service Manual 2020) was developed subsequent to the approval and signing of the 1990 Forest Plans. Resilience is defined as the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change (Forest Service Handbook 1909.12). While the foundational policy for national forests is to achieve sustainable management, and provide a broad range of

ecosystem services, forest plans determine the management approach to achieving sustainability by defining objectives, desired conditions, standards and guidelines, and predicting outcomes.

Climate change is likely to result in consequences for ecological resilience of all resources and is part of the baseline condition. Climate change is included in the cumulative effects analyses throughout Chapter 3 of this document.

Predicted Indicators (to reflect the level of management activity):

- Annual forested vegetation active restoration activities (acres)
- Road treatments in priority watersheds (miles)
- Forage use in priority watersheds (intensity)
- Improved riparian areas (miles)

Key Indicators (to reflect resilient conditions)

- Watersheds in improved conditions
- Vegetation departure index value in the dry upland forest potential vegetation groups at year 50

Chapter 2. Alternatives, Including the Modified Proposed Action

This chapter describes and compares the eight management alternatives for revising the 1990 Forest Plans for the three National Forests in the Blue Mountains. Alternatives B, C, D, E, and F were presented in the Draft Environmental Impact Statement and were developed based on public involvement during and prior to the scoping period as well as based on the purpose and need and issues described in Chapter 1. Alternative E-Modified and Alternative E-Modified Departure were largely developed in response to public comments from the Draft Environmental Impact Statement.

Chapter 2 presents a range of reasonable alternatives, as required by National Environmental Policy Act regulations (40 CFR 1502.14). The 1969 National Environmental Policy Act requires that an environmental impact statement include analysis of a No-Action Alternative (40 CFR 1502.14(d)). No action means there would be no change in current management (FSH 1909.15(14.2)). Alternative A is the No-Action Alternative. This alternative would continue management of the three National Forests according to the 1990 Forest Plans, as amended.

All other alternatives modify components of the 1990 Forest Plans to respond to new scientific information, management challenges, changed conditions, and the significant issues developed from public comments.

The alternatives provide a framework for analyzing different ways of meeting the purpose and need of the forest plans and for addressing the issues described in Chapter 1. The alternatives show a range of options for guiding land and resource management activities on the three National Forests. The key purpose of this document is to describe in detail the environmental consequences of implementing any one of the alternatives.

Appendix A in Volume 4 provides a detailed description and comparison of the full set of plan components for each alternative considered in detail.

Developing the Alternatives

The alternatives include different options to address issues and to respond to the purpose and need discussed in Chapter 1. The public; other Federal, state, and local agencies; and Forest Service employees contributed to the identification of eight issues that are compared in this Final Environmental Impact Statement. The Forest Service used an interdisciplinary approach to analyze the six issues as the primary basis for developing the plan revision alternatives. While all alternatives provide a range of multiple uses and goods and services, each responds to the six issues in different ways.

Public participation initially included collaborative workshops, field trips, meetings, and comments received during the 2010 scoping period and after the distribution of the 2014 Draft Environmental Impact Statement. Each of the steps taken with the public have helped to focus issue development and preparation for this Final Environmental Impact Statement.

Forest Service Management and the Blue Mountains Interdisciplinary Team carefully reviewed over 1,100 public letters (and 4,300 comments within them) that were received after the release of

the 2014 Draft Environmental Impact Statement. The purpose of the review was to identify substantive comments that could be used to further strengthen and enhance the Revised Forest Plans for the three National Forests using the iterative NEPA process. The process began by reaching out to consult, coordinate, and communicate with interested stakeholders, cooperators, and collaborators about the substantive comments we received and to expand upon the ideas. Subsequent discussions that resulted from the iterative review process included:

- Further consultation with American Indian Tribes, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service to go beyond the 2008 Regional ARCS by creating the 2018 Blue Mountains ARCS, which includes updating information based on both proven and best science available;
- Cooperative meetings with the Oregon and Washington Departments of Fish and Wildlife, and American Indian Tribes to incorporate concerns and finding some resolving such as defining elk security habitat, and redefining bighorn sheep guidelines;
- Working with counties to hear their concerns regarding socio-economic conditions, and
- Further discussions with cooperating agencies, American Indian Tribes, State and local governments about the two additional alternatives created as a result of public comments: Alternative E-Modified and Alternative E-Modified Departure.

Ensuring the alternatives fall within the range of the minimum and maximum resource potentials established in the benchmark analysis has also been a focus of this planning effort, as required by regulation (1982 Planning Rule Provisions 36 CFR 219.12(e)(1)).

All alternatives address the six issues identified in Chapter 1. The differences between the alternatives are based on how they respond to the six issues relative to the plan components.

Description and Comparison of the Alternatives

The following sections describe and compare the alternatives. For each alternative, the description begins with the alternative theme and is followed with an explanation of how the alternative responds to the issues. This section ends with a comparison of the alternatives. Tables 1, 2, and 3 compare alternatives using the values for the key indicators for each issue for each of the three National Forests.

For a detailed description of the alternatives, including Alternative A, the No-Action Alternative, refer to Appendix A, Volume 4, which gives the details of plan components for each alternative.

Elements Common to the Plan Revision Alternatives

Plan Components

Forest plans include the following components: goals and desired conditions, management areas, objectives, suitable uses and activities, standards and guidelines, and monitoring. Some components differ little between the plan revision alternatives. The goals and desired conditions are generally the same for the plan revision alternatives, with limited exceptions, which are noted in Appendix A. These desired conditions are the result of public involvement and reflect the best available scientific information, including the Interior Columbia Basin Ecosystem Management Project (USDA Forest Service 2000), the Pacific Northwest Region Aquatic and Riparian Conservation Strategy, and more.

Monitoring is a tool to inform adaptive management that is used to determine if the Forest Plan is being implemented as intended and if projects implemented using its management direction are moving the national forest resources toward desired conditions, or achieving the goals and desired conditions as expected. Monitoring results are used to determine if there is a need to change plan components. Many elements of the monitoring plan are the same for all plan revision alternatives.

Management Focus

A strategy for the proposed action was developed to guide future development of projects and activities within the national forests. This strategy is included in the plan revision alternatives. The identification of management focal points highlights those areas where immediate improvements to the resilience of the Blue Mountains ecosystem could be made or areas that are most sensitive from a social perspective. Considering these factors, drivers for active restoration priorities are:

- Priority watersheds
- Wildland-urban interface
- Dry vegetation groups

Areas where multiple drivers overlap are a higher priority than those with only a single driver. Depending on cost sharing or other factors, lower priority work may still occur before higher priority work. This prioritization also recognizes the need for maintenance activities to prevent areas from becoming departed and then needing more expensive restoration treatments.

Assumptions

Various assumptions were made related to timber and wildland fire in the development of the plan revision alternatives that warrant highlighting here.

- The use of wildland fire as a tool may occur on all acres in all alternatives, with some exceptions described in Alternative D, so long as those fires are moving the landscape towards or helping maintain the desired condition.
- The majority of forest vegetation restoration treatments would be scheduled in dry forest groups.
- No even-aged management regeneration harvests would be scheduled within current old forest stands, and limited harvest of trees 21 inches diameter or larger would occur and would meet the direction stated in Goal 1.14, Old Forest and Individual Old/Large Trees (see Revised Forest Plan Guideline OF-1G).
- All areas that meet the criteria for recommended wilderness areas are rated as unsuitable for timber production and timber harvest.
- In areas identified as unsuitable for timber production due to regeneration difficulty or unstable soils, no harvest would be scheduled.
- Timber harvest restoration activities would focus in areas with established road systems (primarily within MA 4A General Forest).
- All fuels generated by management activities would be managed to meet the desired conditions for down wood.
- Prescribed fire outside of timber harvest units may or may not utilize thinning or piling as a pretreatment depending on anticipated fire effects in relation to the desired conditions.

- The amount of prescribed fire outside of harvest units is constant among alternatives (except Alternative D), with the assumption that current levels of prescribed fire are within the current budgetary and organizational capacity of the Forest Service.
- All vegetation treatments (wildland fire and timber harvest) are assumed to improve resilience by moving all potential vegetation groups toward the desired conditions.

Alternative A: No-Action Alternative (the Current Forest Plans)

Alternative A, would continue management direction under the 1990 Forest Plans as amended. The portion of the Ochoco National Forest administered by the Malheur National Forest's Emigrant Creek Ranger District would continue to be administered using the 1989 Forest Plan for the Ochoco National Forest. These Forest Plans emphasized the production of wood products using even-aged management and assumed that ecological conditions were healthy and that disturbances, such as wildland fire or insect and disease outbreaks, would not substantially affect planned actions, desired outcomes or outputs.

The existing Forest Plans provide a mix of natural resource-based goods and services, such as timber and wood products, livestock forage, big game, and minerals in an environmentally sound manner. This alternative reflects the current level of goods and services provided by each administrative unit and the most likely amount of goods and services expected to be provided in the future if current management direction continues (36 CFR 219.12(f)(7) 1982). At the same time, Alternative A provides for other uses and values, such as scenery, recreational opportunities, wildlife habitat, and clean air and water. The PACFISH, INFISH, and Eastside Screens amendments to the Forest Plans, intended to provide interim direction until forest plans were revised, would continue.

Issues

Issue 1: Access

Each alternative address access issues in the configuration of management areas, the area suitable for summer and winter motor vehicle use and trail construction, and through desired conditions, standards, and guidelines. The management areas remain unchanged in Alternative A.

There would be no additions to the backcountry areas, no additional wildlife corridors or recommended additions to wilderness. The areas suitable for summer and winter motor vehicle use would not change. Suitable uses for each management area would be those described in the 1990 Forest Plans.

The 1990 Forest Plans have standards for road density that vary by forest and management areas within the forests. Within the Malheur National Forest, the forest-wide open road density standard varies by management area from 1.5 to 3.2 miles per square mile, and off-route motor vehicle travel is authorized unless otherwise restricted.

Within the Umatilla National Forest, the open road density desired condition is 2.0 miles per square mile, and motor vehicle use is limited to designated routes.

Within the Wallowa-Whitman National Forest, the open road density guideline is 2.5 miles per square mile for general forest and 1.5 miles per square mile for summer and winter elk range management area, and off-route motor vehicle travel is authorized unless otherwise restricted.

Issue 2: Economic and Social Well-being

The 1990 Forest Plans projected robust economic returns to the local communities from management activities, but the returns were realized only during the first few years of implementation. PACFISH, INFISH, and Eastside Screen amendments addressed habitat needs for listed fish species and other old forest-associated ecosystems. However, these amendments did not adjust the timber suitability calculations and the allowable sale quantity. The analysis for this alternative updates the allowable sale quantity, long-term sustained yield, and timber sale program quantity for all three National Forests using the amended direction and carries the updated figures through the comparison of alternatives and the effects analysis.

Jobs and income are associated with resource flows and uses. The predicted annual timber volume sold for the Blue Mountains national forests for Alternative A is 79 million board feet. This would support about 608 jobs and $35 million in wages associated with timber harvest, primary wood products manufacturing, and associated industries. Based upon the current number of grazing permits, 242,800 cattle and sheep animal unit months (AUMs) are projected. This would support about 895 jobs and generate about $15.4 million in wages. Recreation within the Blue Mountains national forests is estimated to be 574,000 visits annually. Expenditures by the visitors including local residents support about 176 jobs with $4.6 million in wages.

The annual Forest Service budget expenditures needed to fully implement management activities under Alternative A are estimated to be $72.5 million dollars. This is consistent with recent budget allocations.

Issue 3: Livestock Grazing and Grazing Land Vegetation

Animal unit months (AUMs) have declined since 1990 due to the Federal listing of fish species per the Endangered Species Act and the PACFISH and INFISH amendments to the 1990 Forest Plans. This more restrictive management direction for livestock grazing in riparian areas resulted in reduced seasons of use or livestock numbers. Within the Blue Mountains national forests, 187,000 acres are suitable for sheep grazing, and 1,889,000 acres are suitable for cattle grazing. Progress toward achieving desired conditions for rangeland vegetation and livestock grazing would be slow to moderate. The potential for disease transmission from domestic sheep to bighorn sheep is managed in cooperation with State wildlife agencies.

Issue 4: Old Forest

Alternative A includes designated old forest management areas. Designated old forest management areas are not suitable for timber production per management direction in the 1990 Forest Plans. The single exception is timber harvest in managed old forest stands within the Umatilla National Forest, but only for the purpose of enhancing wildlife habitat. The 1990 Forest Plans include standards for snag retention and green tree replacement that provide management direction for retention of some old forest characteristics outside of designated old forest stands. The Eastside Screens Forest Plan Amendment added additional requirements for doing so. As a result, stands with late and old forest structure are managed to retain and develop structure and patch sizes within the historic range of variability, and harvest of trees 21 inches diameter or larger is severely limited.

Issue 5: Recommended Additions to the National Wilderness Preservation System

Under Alternative A, no areas would be recommended for addition to the National Wilderness Preservation System.

Issue 6: Ecological Resilience

The current forest plans, as amended, consider ecological conditions by managing to attain or maintain forest vegetation within a historic range of variability. However, under Alternative A, continuing current management is anticipated to result in minor improvements to ecological resiliency. The vegetation departure index value for the dry upland forest potential vegetation group at year 50 would improve to a small degree over existing conditions. And the number of subwatersheds anticipated to be improved are few.

Alternative B: The Modified Proposed Action

Alternative B emphasizes restoring landscape functions and processes to create resilient landscapes that are adaptable to climate change. Alternative B includes desired conditions that would emphasize an integrated strategy for managing National Forest System lands. Management allocations would become more consistent between the three National Forests. Alternative B would emphasize a combination of active management and natural processes to restore landscapes on the three National Forests.

Substantial public input contributed to the development of the proposed action. Based on a series of public meetings and coordination between 2003 and 2010 with various interest groups, including Tribal, local and State governments and Federal agencies, several needs for revising the 1990 Forest Plans were identified. A proposed action was developed to address those needs for change and it was distributed for public review as part of public scoping in March 2010. Based on public response to the proposed action, the following modifications were incorporated into the proposed action as Alternative B:

- Plan components include consideration of possible climate change scenarios where appropriate. Desired conditions for plant species composition and stand density better reflect how management direction would be used in project planning.
- Acre figures reflect finalized management area boundaries.
- The general suitability table includes fewer activities, but renewable/wind energy development was added as an activity.
- The objectives better described management activities and program outcomes necessary to maintain or achieve desired conditions. The objectives are displayed separately for each national forest.
- Additions, deletions, and modifications to standards and guidelines accounted for new information and reduce redundancy with direction existing at that time. The standards and guidelines are displayed for each national forest.
- The monitoring section includes more than the minimum legally required items and identifies management indicator species.

Issues

Issue 1: Access

The suitability rating of management areas for motor vehicle use during summer and winter, as well as trail construction for motorized use varies by alternative depending on the management area configuration of the alternative. Alternative B allocates areas for recommended wilderness area (MA 1B), which would be rated suitable for over-snow motor vehicle use. This alternative would also designate both nonmotorized (MA 3A) and motorized (MA 3B) backcountry management areas. Both summer and winter motor vehicle use would be considered unsuitable in nonmotorized areas (MA 3A). This alternative would not designate any wildlife corridor (MA 3C).

Open motor vehicle route density would change from a standard and/or guideline to a desired condition depending on the management area and winter elk habitat. The desired condition for open motor vehicle route density in motorized backcountry management areas would have a desired condition of 1.5 miles per square mile. General Forest (MA 4A) management would have an open route density of 2.4 miles per square mile. Winter elk habitat would have a desired condition of 1.5 miles per square mile. Road maintenance for Alternative B would be similar to Alternative A.

Key Indicators

Key indicator values represent the combined values for the three Blue Mountains national forests:

- Projected annual road maintenance: 2007 miles
- Acres suitable for summer motorized use: 3,919,800 acres
- Acres suitable only for nonmotorized summer use: 915,200 acres
- Acres suitable for winter over-the-snow motor vehicle use: 3,933,200 acres

Issue 2: Economic and Social Well-being

The predicted annual timber volume sold for the Blue Mountains national forests for Alternative B is approximately 112 million board feet. This timber volume sold would support about 874 jobs and $50.1 million in wages associated with timber harvest, primary wood products manufacturing, and associated industries. This is more than projected for Alternative A. Alternative B provides slightly less grazing capacity than Alternative A with an expected 239,600 cattle and sheep animal unit months. This level of animal unit months would support about 854 jobs that would generate about $15.1 million in wages. Recreation within the Blue Mountains national forests is estimated to be at 574,000 visits annually. Expenditures by the visitors support about 176 jobs with $4.6 million in wages.

The annual Forest Service budget expenditures needed to fully implement management activities under Alternative B are estimated to be $72.5 million dollars. This is consistent with Alternative A and recent budget allocations.

Key Indicators:

- Timber harvest jobs: 874
- Timber harvest income (thousands): $50,093
- Livestock grazing jobs: 854
- Livestock grazing income (thousands): $15,140

- Timber volume planned for sale/timber sale program quantity (TSPQ) in million board feet per year: 112 million board feet

Issue 3: Livestock Grazing and Grazing Land Vegetation

Acres suitable for grazing would be slightly lower than Alternative A, about 2 million acres. The amount of animal unit months (AUMs) for cattle would be slightly higher (about a half percent) compared to Alternative A. Animal unit months for grazing sheep would be slightly reduced compared to Alternative A to lessen the risk of disease transmission from domestic sheep to bighorn sheep.

Key Indicators:

- Area suitable for cattle and sheep grazing: 2,076,000 acres
- Animal unit months (cattle): 225,000
- Animal unit months (sheep): 14,600

Issue 4: Old Forest

Under Alternative B, the Forest Plans would not include old forest management areas. The management of old forest would be guided by the desired conditions, such as forested structural stages, stand density, and species composition. Vegetation treatments, both timber harvest and the use of wildland fire, are designed to improve resilience to disturbance while making progress toward a greater abundance of old forest stands. Alternative B includes a guideline (OF-1G) that would emphasize retaining trees 21 inches diameter and larger, with some exceptions.

Key Indicators

- Amount of old forest within management area allocations with limited management activity: 421,000 acres
- Acres of estimated timber harvesting within old forest: 1,600 acres
- Percent old forest at year 50 (all potential vegetation groups): 21 to 31 percent
- Percent dry upland forest old forest single story at year 50: 8 to 11 percent

Issue 5: Recommended Additions to the National Wilderness Preservation System

Alternative B proposes to recommend 13,400 acres for preliminary administratively recommended additions to the National Wilderness Preservation System.

Issue 6: Ecological Resilience

For Alternative B, the levels of annual forested vegetation active restoration activities proposed to restore ecological resilience would be similar to Alternative A. All ecological key indicators values for Alternative B are similar to Alternative A and are listed below (values represent the combined values for the three Blue Mountain national forests):

- Annual forested vegetation active restoration activities (acres): 54,250 acres
- Miles of road treatment in priority watersheds: 780 miles
- Forage use intensity: 11-16%
- Miles of riparian area improvement: 700 miles
- Number of subwatersheds in improved condition: 33

- Vegetation departure index value in the dry upland forest potential vegetation group at year 50: 46-52

Alternative C

Alternative C varies from Alternative B by emphasizing the role of natural processes in forest restoration (also referred to as passive restoration). When compared to the other alternatives, less timber would be harvested, more area would be allocated for nonmotorized recreation, and more area would be allocated to recommended wilderness areas. Similar to Alternative A, old forest would be mapped and allocated to a management area. The harvest of large trees (21 inches diameter or larger) would be prohibited with no exceptions. Managed wildland fire for resource benefit to achieve the desired condition would be highest in this alternative. Wildlife corridor management areas would be mapped and allocated to Management Area 3C. This alternative would make substantial reductions to the permitted number of domestic livestock. The default width of riparian management areas would be greater than what is proposed for the other alternatives.

Issues

Issue 1: Access

The alternatives address access issues through the design of management areas; suitability for summer and winter motor vehicle use and trail construction; and the desired conditions, standards and guidelines. Nonmotorized uses would be emphasized in this alternative. Wildlife Corridor (MA 3C) is proposed, as are backcountry nonmotorized (MA 3A) and recommended wilderness areas (MA 1B). No National Forest System lands would be designated as motorized backcountry (MA 3B).

This alternative designates the most recommended wilderness area (MA 1B), approximately 500,000 acres, which would not be suited for over-snow motor vehicle use.

The desired condition for open motor vehicle route density within watersheds in MA 3C is 1 mile per square mile or less. All cross-country over-the-snow vehicle travel would be prohibited in MA 3C, where over-the-snow vehicle travel would be permitted only on routes designated open to summer motor vehicle travel.

The desired condition for open motor vehicle route density within watersheds in General Forest (MA 4A) is 2.4 miles per square mile or less. Within subwatersheds, an exception is made for winter elk habitat, where the open motor vehicle route density is 1.5 miles per square mile or less.

Alternative C would provide the least amount of area considered generally suitable for motor vehicle use in summer and in winter and represents a reduction compared to Alternative B. Alternative C would provide the greatest amount of area rated suitable only for nonmotorized summer use and represents an increase compared to Alternative B.

Road maintenance projections are the lowest for Alternative C and represent approximately one fourth the amount of Alternative B.

Issue 2: Economic and Social Well-being

The predicted annual timber volume sold for the Blue Mountains national forests for Alternative C is approximately 41 million board feet, the smallest projection among all of the alternatives.

This would support about 318 jobs and $18.2 million in wages associated with timber harvest, primary wood products manufacturing, and associated industries.

Domestic livestock grazing would be reduced to 95,900 animal unit months, which would support about 339 jobs and generate about $6 million in wages.

Recreation within the Blue Mountains national forests is estimated at 574,000 visits annually. Expenditures by the visitors support about 176 jobs with $4.6 million in wages.

The annual Forest Service budget expenditures needed to fully implement management activities under Alternative C are estimated to be $68.3 million dollars. This is the lowest level of budget needs among the considered alternatives. Alternative C budget needs are less than recent budget allocations.

Issue 3: Livestock Grazing and Grazing Land Vegetation

The area that would be generally suitable for cattle grazing and sheep grazing would be reduced to approximately 785,000 acres, and 90,000 acres, respectively, the least amount of area among alternatives. For cattle grazing, these decreases would result from the classification of riparian areas and subwatersheds with habitat for listed fish species as generally unsuitable for cattle grazing. For sheep grazing, the decrease would result from the classification of subwatersheds within the maximum foray distance for bighorn sheep rams as generally unsuitable for sheep grazing. Because of the decrease in the land area suitable for livestock grazing, the fewest estimated cattle and sheep animal unit months are projected under Alternative C.

Issue 4: Old Forest

Old forest (390,900 acres) would be allocated to MA 4C Old Forest. Only trees 8 inches diameter or less would be authorized for timber harvest in this management area. This alternative would include a standard that would strictly prohibit the harvesting of trees 21 inches diameter and larger, both within and outside of old forest.

Under Alternative C, the proportion of old forest structure within all potential vegetation groups at year 50 would be the same as for Alternative B, ranging from 21 to 31 percent National Forest. However, the percentage of the dry upland forest in the old forest single story stage would be lower than projected for all other alternatives due to less aggressive forest management strategies, 10 percent for the Malheur National Forest, 11 percent for the Umatilla National Forest, and 7 percent for the Wallowa-Whitman National Forest.

Issue 5: Recommended Additions to the National Wilderness Preservation System

Approximately 505,000 acres would be a preliminary administratively recommended additions to the National Wilderness Preservation System, the largest projection of the alternatives.

Issue 6: Ecological Resilience

Alternative C is designed to emphasize the role of natural processes in the restoration of ecological resilience. Forested vegetation mechanical restoration treatments and forage use intensity would be the lowest among all other alternatives. With the exception of Alternative D, roads treatments would be greater than the other alternatives, almost double the miles compared to Alternative B. Alternative C would improve the most miles of riparian areas, double the number estimated for Alternative B. The greatest amount of subwatersheds would be improved,

but the vegetation departure score at year 50 for the dry upland forests would improve the least among alternatives.

Alternative D

Alternative D, developed in coordination with the cooperating counties, would increase active management of forest and range vegetation to maximize the outputs of goods and services, while meeting minimum requirements to conserve other resources such as soils and water quality. Alternative D projects the highest volumes for timber harvest and would emphasize active management using mechanical treatments to restore the forested landscape. Alternative D responds to requests to increase public motor vehicle access. No areas would be allocated to preliminary administratively recommended wilderness areas (Management Area 1B). This alternative does not include a standard or guideline prohibiting the harvest of trees 21 inches diameter or larger, but relies exclusively on desired conditions. This alternative proposes the smallest riparian management area.

Issues

Issue 1: Access

This alternative does not designate any Wildlife Corridor (MA 3C), backcountry nonmotorized (MA 3A) or recommended wilderness areas (MA 1B) that would be unsuitable for motorized use. This alternative designates backcountry motorized (MA 3B), which are suitable for both summer and winter motor vehicle use.

The desired condition for open motor vehicle route density within watersheds in General Forest (MA 4A) is 3 miles per square mile or less. Within subwatersheds, an exception is made for winter elk habitat, where the open motor vehicle route density is 1.5 miles per square mile or less.

This alternative emphasizes retaining the areas that currently are generally suitable for motor vehicle use, resulting in more area suitable for summer and winter motor vehicle use than proposed by the other alternatives. Alternative D would provide the most amount of area considered generally suitable for motor vehicle use in summer and in winter and represents an increase compared to Alternative B. Alternative D would provide the least amount of area rated suitable only for nonmotorized summer use and represents a decrease compared to Alternative B.

Road maintenance projections are the highest for Alternative D, primarily because more roads would be open for motor vehicle use and would be maintained.

Issue 2: Economic and Social Well-being

The projected annual timber volume sold for the Blue Mountains national forests for Alternative D is approximately 353 million board feet. This would support about 2,765 jobs and $158.4 million in wages associated with timber harvest, primary wood products manufacturing, and associated industries. This is the largest projection among the alternatives. The estimated 245,800 cattle and sheep animal unit months are slightly more than Alternative A. Domestic livestock grazing would support about 889 jobs and generate about $15.6 million in wages. Recreation within the Blue Mountains national forests is estimated at 574,000 visits annually. Expenditures by visitors would support about 176 jobs with $4.6 million in wages.

The annual Forest Service budget expenditures needed to fully implement management activities under Alternative D are estimated to be $83.3 million dollars. This would be the most costly

alternative to fully implement. Full implementation of Alternative D would require approximately $10 million more per year than recent budget allocations.

Issue 3: Livestock Grazing and Grazing Land Vegetation

The amount of animal unit months (AUMs) for cattle would be slightly higher than the other plan revision alternatives. The area that would be generally suitable for cattle grazing would be increased to approximately 1,922,000 acres, the most area among alternatives. Projected animal unit months for grazing sheep would be fewer than current levels to reduce the risk of disease transmission from domestic sheep to bighorn sheep. Alternative D would use desired conditions to address livestock grazing and rangeland vegetation rather than rely on the standards and guidelines proposed for all other alternatives.

Issue 4: Old Forest

Alternative D, as with Alternatives B, E, E-Modified, E-Modified-Departure, and F, would not include the designation of old forest management areas. The management of old forest would be guided exclusively by the desired conditions, such as for forested structural stages, stand density, and species composition, without additional old tree standards or guidelines. Vegetation treatments would be designed to improve resilience to disturbances while making progress toward a greater abundance of old forest stands and would emphasize mechanical treatments rather than wildland fire use (planned or unplanned ignitions).

Under Alternative D, the proportion of the landscape projected for old forest structural stages in all potential vegetation groups at year 50 would be 20 percent for the Malheur National Forest, 26 percent for the Umatilla National Forest, and 30 percent for the Wallowa-Whitman National Forest. These projections are slightly lower compared to Alternative B. Within the dry upland forest potential vegetation groups, the proportion of the forestland projected for year 50 would be 11 percent for the Malheur National Forest, 14 percent for the Umatilla National Forest, and 16 percent for the Wallowa-Whitman National Forest, slightly higher compared to alternative B.

Issue 5: Recommended Additions to the National Wilderness Preservation System

Alternative D would not allocate areas to preliminary administratively recommended wilderness areas (Management Area 1B).

Issue 6: Ecological Resilience

Alternative D would pursue an aggressive approach to restoring the ecological resilience of forested vegetation through active management to maximize economic return to the local economy. Forested vegetation mechanical restoration treatments would be intermediate compared to the other alternatives. Forage use intensity would be a few percent higher than Alternative B, Roads treatments under Alternative D would be highest compared to other alternatives. The amount of subwatersheds that would be improved are higher than Alternative B. The vegetation departure index value projected for the dry upland forest potential vegetation group at year 50 improves compared to Alternative B.

Alternative E

Alternative E would use vegetation management and aquatic and wildlife habitat treatments to increase the scale of restoration activities, while emphasizing the potential benefits to water

quality and watershed condition. Alternative E responds to public concerns and questions (raised in Issue 6) regarding the environmental effects of accelerating efforts to improve ecological resilience. While similar in many regards to Alternative B, Alternative E would increase objectives for both the number and extent of restoration projects that would be undertaken on the Blue Mountains national forests. Objectives for riparian and aquatic habitat improvement activities and road maintenance proposals to improve aquatic conditions within key and priority watersheds would be significantly greater than proposed in Alternative B.

Issues

Issue 1: Access

The approach to managing access would be similar to Alternative B, with a few exceptions. This alternative identifies preliminary administratively recommended wilderness areas (MA 1B), which would allow for the use of over-snow motor vehicle use in winter. Alternative E designates a small amount of wildlife corridor (MA 3C), linking high quality, unroaded wildlife habitats which would allow the suitable use of motor vehicle use in summer and winter on designated routes. This alternative would also identify both nonmotorized (MA 3A) and motorized (MA 3B) backcountry management areas. Both summer and winter motor vehicle use would be considered unsuitable in nonmotorized areas (MA 3A).

Alternative E differs from the proposed action by moving away from road densities in general forest (MA 4A) to instead focus on roads that are affecting wildlife and impairing fish populations and aquatic ecosystems across the landscape.

The desired conditions for this alternative propose to reduce road-related sedimentation by reducing road density and reducing the hydrologic connectivity of the road system; that is, disconnecting the road beds from stream systems. Road treatments may include replacing undersized culverts, out-sloping roads, hardening surfaces to reduce erosion, or occasionally relocating or decommissioning roads, and would address roads with a focus on watersheds with threatened and endangered aquatic fish species. Open motor vehicle route density would change from a standard or guideline (as in Alternative A) to a desired condition depending on the management area and presence of winter elk habitat. The open motor vehicle route density in MA 3C would be no greater than 1 mile per square mile. Winter elk habitat would have a desired condition of 1.5 miles per square mile.

Alternative E would provide an intermediate amount of area considered generally suitable for motor vehicle use in summer and winter and represents a slight increase compared to Alternative B for the Malheur National Forest for winter vehicle use, and a slight decrease compared to Alternative B for the both the Umatilla and Wallowa-Whitman National Forests. Alternative E would provide an intermediate amount of area rated suitable only for nonmotorized summer use and represents an increase compared to Alternative B. Road maintenance for Alternative E would be slightly more but similar to Alternative B.

Issue 2: Economic and Social Well-being

The projected annual timber volume sold for the Blue Mountains national forests is approximately 203 million board feet, significantly more than projected for Alternative B. This level of timber volume sold would support about 1,585 jobs and about $90.7 million in wages associated with timber harvest, primary wood products manufacturing, and associated industries. The projected 239,800 cattle and sheep animal unit months are similar to projections for Alternative B, and would support about 865 jobs and generate about $15.2 million in wages.

Recreation within the Blue Mountains national forests is estimated at 574,000 visits annually. Expenditures by the visitors support about 176 jobs with $4.6 million in wages.

The annual Forest Service budget expenditures needed to fully implement management activities under Alternative E are estimated to be $78.5 million dollars. This is greater than Alternatives A, B, and C, but less than Alternative D. The full implementation of Alternative E would require approximately $6 million more per year than recent budget allocations.

Issue 3: Livestock Grazing and Grazing Land Vegetation

The area that would be generally suitable for cattle grazing (1,889,000 acres) and projected animal unit months (224,000 AUMs) would not change from current levels, and would be within 1 percent of the values for Alternative B. The area that would be suitable for sheep grazing (168,000 acres) would reduce about 10 percent from current levels but is about 10 percent more than Alternative B. To reduce the risk of disease transmission from domestic sheep to bighorn sheep, projected animal unit months for grazing sheep (15,800) would be about 16 percent lower than current levels, and approximately 8 percent more than the values for Alternative B.

Issue 4: Old Forest

Alternative E does not include the designation of old forest management areas, similar to other plan revision alternatives except Alternative C. The management of old forest would be guided by the desired conditions, such as forested structural stages, stand density, and species composition with additional old tree guidelines. Alternative E further includes a guideline that emphasizes retaining trees with certain old tree characteristics, both within and outside of old forest stands. For most tree species, certain tree characteristics can be used as a fairly reliable indicator of older age (generally greater than 150 years old, but this varies by species and site).

Under Alternative E, the proportion of the landscape in old forest structural stages for all potential vegetation groups projected at year 50 is 30 percent for the Malheur National Forest, 27 percent for the Umatilla National Forest, and 21 percent for the Wallowa-Whitman National Forest. Within the dry upland forest potential vegetation groups, the proportion of the old forest single-story stage at year 50 would be 16 percent for the Malheur National Forest, 15 percent for the Umatilla National Forest, and 11 percent for the Wallowa-Whitman National Forest. This would be due to increased timber harvest resulting in more open stand densities and increased growth of the residual trees, creating more larger-diameter trees. These values are nearly identical to the values for Alternative B. Vegetation treatments would emphasize both mechanical treatments and wildland fire use (planned and unplanned ignitions).

Issue 5: Recommended Additions to the National Wilderness Preservation System

Approximately 90,800 acres would be allocated to MA 1B (preliminary administratively recommended wilderness areas) under Alternative E.

Issue 6: Ecological Resilience

For Alternative E, the total acres of projected forested vegetation mechanical restoration treatments would be third highest among alternatives, about 30 percent more than the value for Alternative B. Objectives for road treatments (miles) and improved riparian areas (miles) are greater than objectives for Alternative B. Forage use intensity would be the same as for Alternative B. The number of subwatersheds that would be improved would be slightly higher

than for Alternative B. The dry forest fire regime condition class departure score would improve by 8 points for the Malheur National Forest, 6 points for the Umatilla National Forest, and 7 points for the Wallowa-Whitman National Forest, substantially more compared to Alternative B. Alternative E would further be expected to result in increased ecological resiliency in the dry upland forest potential vegetation groups because fuel composition, fire frequency, severity, pattern, and other associated disturbances would more closely resemble the historic range of variability.

Alternative E-Modified

Alternative E-Modified was developed in response to comments received from the public, State and local governments, Tribes, and other Federal agencies to the draft Revised Plan (Alternative E in the Draft Environmental Impact Statement). These modifications of Alternative E include:

- adding new standards and guidelines while eliminating others;
- making relatively small changes in the area (acres) of lands suitable for various uses;
- increasing slightly livestock animal unit months;
- reducing the area of lands recommended for addition to wilderness; and
- omitting designated connective wildlife corridors.

Alternative E-Modified emphasizes active restoration through vegetation management, and it incorporates the 2018 Blue Mountains Aquatic and Riparian Conservation Strategy. This strategy would promote improvements to aquatic and terrestrial wildlife habitats while increasing management flexibility.

Both riparian and aquatic habitat improvement activities and road maintenance proposals for investments in aquatic restoration within key and priority watersheds are similar to Alternative E but are significantly greater than are proposed in Alternative B.

Alternative E-Modified would maintain an overall level of projected timber volume sold similar to Alternative E. To protect old trees this alternative includes a revised old tree guideline (OF-G1) that would emphasize retaining trees having certain old tree characteristics with certain specific exceptions (see Appendix A, Volume 4).

Issues

Issue 1: Access

The approach to managing access in Alternative E-Modified would be similar to Alternative B. Alternative E-Modified would identify both nonmotorized (MA 3A) and motorized (MA 3B) backcountry management areas. Both summer and winter motor vehicle use would be considered unsuitable in nonmotorized areas (MA 3A).

Open motor vehicle route density would change from a standard and/or guideline in Alternative A to a desired condition depending on the management area and elk security. An objective for this alternative is to consider restoration and maintenance in areas where Forest Service routes are specifically identified as a factor in road-related sedimentation affecting riparian conditions.

This alternative differs from Alternative A by moving away from road densities in general forest (MA 4A) to focus instead on elk security and on roads resulting in the greatest impacts to fish and aquatic ecosystems on the landscape. In this alternative, the desired condition would focus on

hydrologically disconnecting the roadbed from the stream system with a focus on watersheds with threatened and/or endangered aquatic fish species. This would involve replacing undersized culverts, out-sloping roads, hardening surfaces to reduce erosion, and occasionally (where identified as necessary) relocating or decommissioning roads where necessary to restore habitat needed for threatened and endangered aquatic fish species.

Alternative E-Modified would provide an intermediate amount of area considered generally suitable for motor vehicle use in summer and in winter and represents similar values, with a slight decrease, compared to Alternative B. Alternative E-Modified would provide an intermediate amount of area rated suitable only for nonmotorized summer use and represents an increase compared to Alternative B. Road maintenance for Alternative E-Modified would be slightly more but similar to Alternative B.

Issue 2: Economic and Social Well-being

The predicted annual timber volume sold for the Blue Mountains national forests for Alternative E-Modified is approximately 205 million board feet, similar to Alternative E, more than projected for Alternative A but less than projected for Alternative D. This level of timber volume sold would support about 1,593 jobs and $91.2 million in labor income associated with timber harvest, primary wood products manufacturing, and associated industries. The projected 294,400 cattle and sheep Animal Unit Months are similar to projections for Alternative B, and would support about 1,083 jobs and generate about $18.7 million in wages. Recreation within the Blue Mountains national forests is estimated at 574,000 visits annually. Expenditures by recreation visitors would support about 176 jobs with $4.6 million in wages.

The annual Forest Service budget expenditures needed to fully implement management activities under Alternative E-Modified are estimated to be $78.5 million dollars. This is greater than Alternatives A, B, and C, but less than Alternative D. The full implementation of Alternative E-Modified would require approximately $6 million more per year than recent budget allocations.

Issue 3: Livestock Grazing and Grazing Land Vegetation

Alternative E-Modified would use the levels from the 2013 permitted animal unit months for both cattle and sheep grazing. The area that would be generally suitable for cattle grazing (2,128,600 acres) and projected animal unit months (272,500 AUMs) which is the highest among all alternatives. Projected animal unit months for grazing sheep (21,900) would be higher than current levels, and approximately 50 percent higher than the value for Alternative B.

Alternative E-Modified incorporates the 2018 Blue Mountains Aquatic Riparian Conservation Strategy grazing guidelines for riparian grazing management, as well as all of the other standards and guidelines for grazing.

Issue 4: Old Forest

Old forest management under Alternative E-Modified is similar to Alternative E, but has higher projections for vegetation management designed to improve old forest characteristics, particularly in the dry upland old forest, single-story potential vegetation type. Within the dry upland forest potential vegetation groups, the proportion of forest in the old forest single-story type would be about 24 percent higher than Alternative E and about a 67 percent higher compared to Alternative B. This would be due to emphasizing treatments in overstocked dry upland forests resulting in more open stand densities. Under Alternative E-Modified, the proportion of the landscape in old

forest structural stages in all potential vegetation groups improves over Alternative B, but to a lesser degree than for the dry upland forest type.

Issue 5: Recommended Additions to the National Wilderness Preservation System

Alternative E-Modified would allocate approximately 70,500 acres to MA 1B (preliminary administratively recommended wilderness areas), which is about 20,000 fewer acres than would be allocated under Alternative E, but 57,000 acres more than for Alternative B.

Issue 6: Ecological Resilience

For Alternative E-Modified, projected forested vegetation restoration treatments would increase slightly compared to Alternative E, but are still significantly higher than for Alternative B. Anticipated miles of road treatments is the same as under Alternated E but and miles of riparian areas improved is 5 percent lower than Alternative E. Both these indicator values are significantly higher than Alternative B. Forage use intensity is the higher than Alternatives B and E. The number of subwatersheds that would be improved is higher than Alternative E, and the same as Alternative B. The improvement in the dry forest vegetation departure index score would be slightly better compared to Alternative E, and significantly better compared to Alternative B.

Alternative E-Modified Departure

Plan components for Alternative E-Modified Departure are identical to plan components for Alternative E-Modified except for objectives that increase the pace and scale of restoration over the next 20 years. The National Forest Management Act limits the allowable sale quantity (ASQ) to a volume that can be harvested annually "in perpetuity," which is known as a "nondeclining even-flow." The intent of nondeclining flow is to prevent higher than sustainable harvest levels in one decade from resulting in lower harvest levels in future decades, which is especially important for communities where a consistent supply of wood products from national forests contributes to and helps maintain the stability of the local economy.

The 1982 planning regulations (219.16 (a)(3)) allow for the evaluation of alternatives that "depart" from the nondeclining even flow requirement if it will lead to better attaining the overall objectives of multiple-use management when any of the following conditions are indicated:

- to significantly reduce or prevent high mortality losses from any cause;
- to improve forest age- or size-class distributions;
- implementation of the base sale schedule would have a substantial adverse impact upon a community in the economic area of the forest; or
- overall multiple-use objectives would otherwise be better attained.

Under Alternative E-Modified Departure, the timber sale program quantity (TSPQ - the estimation of annual timber planned for sale), would increase by 59 percent over Alternative E-Modified. Within 20 years, Alternative E-Modified Departure would thin a larger proportion (approximately 70 percent) of the dense, overstocked, dry, upland forest in lands suitable for timber production compared to Alternative E (approximately 30 percent). With most of the thinning of dry upland forest completed in the first 20 years, harvest levels for Alternative E-Modified Departure would be expected to decrease substantially in future decades, compared to

Alternative E-modified, as the Forests transition to a lower overall sustainable, "maintenance" level of harvest.

Issues

Alternative E-Modified Departure responds to the issues the same as Alternative E-Modified, except for the issues of economic and social well-being, old forest, and ecological resilience; therefore, Issues 1, 3 and 5 will not be repeated here.

Issue 2: Economic and Social Well-being

The predicted annual timber volume sold for the Blue Mountains national forests for Alternative E-Modified Departure is approximately 326 million board feet, more than projected for Alternative A but less than projected for Alternative D. This level of harvest would support about 2,514 jobs and about $144.2 million in wages associated with timber harvest, primary wood products manufacturing, and associated industries. The projected 294,400 cattle would support about 1,083 jobs and generate about $18.7 million in wages. Recreation within the Blue Mountains national forests is estimated at 574,000 visits annually. Expenditures by recreation visitors would support about 176 jobs with $4.6 million in wages.

The annual Forest Service budget expenditures needed to fully implement management activities under Alternative E-Modified Departure are estimated to be $78.5 million dollars. This is greater than Alternatives A, B, and C, but less than Alternative D. The full implementation of Alternative E-Modified Departure would require approximately $6 million more per year than recent budget allocations.

Issue 4: Old Forest

Old forest management under Alternative E-Modified Departure is similar to Alternative E-Modified, but has higher projections for vegetation management designed to improve old forest characteristics, particularly in the dry upland old forest, single-story potential vegetation type. The percent of dry upland old forest single story at year 50 would increase by one percentage point compared to Alternative E-Modified. This would be due to emphasizing treatments in overstocked dry upland forests resulting in more open stand densities and increased growth of the residual trees, creating more larger-diameter trees. The percent of the landscape in old forest structural stages in all potential vegetation groups would be the same as Alternative E-Modified.

Issue 6: Ecological Resilience

For Alternative E-Modified Departure, forested vegetation restoration treatments are projected to increase by approximately 30 percent compared to Alternative E. Road treatments (miles), improved riparian areas (miles), and forage use intensity would all be the same as for Alternative E-Modified. The number of subwatersheds that would be improved is slightly more than projected for Alternative E-Modified. The improvement in the dry forest vegetation departure index score would be similar to Alternative E-Modified. Alternative E-Modified Departure would be expected to result in increased ecological resiliency in the dry upland forest potential vegetation groups because fuel composition, fire frequency, severity, pattern, and other associated disturbances would more closely resemble the historic range of variability.

Alternative F

The management emphasis for Alternative F is the same as stated for Alternative E – to use vegetation management and aquatic and wildlife habitat treatments to increase the scale of restoration activities, while emphasizing the potential benefits to water quality and watershed condition. However, management objectives for active restoration, while greater than proposals made for Alternative B, would be less than the proposals for Alternative E. Both riparian and aquatic habitat improvement activities and road maintenance proposals for aquatic restoration within key and priority watersheds are significantly greater than the Alternative B proposals. The budget assumptions for vegetation treatments would be the same as proposed for Alternative B. Alternative F proposes the same desired conditions and management areas as Alternative B and E.

Issues

Issue 1: Access

The same proposals made for Alternative E are made for Alternative F.

Issue 2: Economic and Social Well-being

The predicted annual timber volume sold for the Blue Mountains national forests for Alternative F is approximately 146 million board feet. This would support about 1,148 jobs and $65.8 million in wages associated with timber harvest, primary wood products manufacturing, and associated industries. This is more than is projected for Alternative B but less than projected for Alternative E. The projected 239,800 cattle and sheep animal unit months would support about 865 jobs that would generate about $15.2 million in wages including estimates for unpaid or family labor contributions. Recreation within the Blue Mountains national forests is estimated at 574,000 visits annually. Expenditures by forest visitors support about 176 jobs with $4.6 million in wages.

The annual Forest Service budget expenditures needed to fully implement management activities under Alternative F are estimated to be $74 million dollars. This is greater than Alternatives A, B, and C, but less than Alternative D. The full implementation of Alternative F would require approximately $1.6 million more per year than recent budget allocations.

Issue 3: Livestock Grazing and Grazing Land Vegetation

The same proposals made for Alternative E are made for Alternative F.

Issue 4: Old Forest

This alternative proposes the same amount of acres treated in old forest as for Alternative E, which is higher compared to Alternative B. Under Alternative F, the proportion of the landscape in old forest structural stages in all potential vegetation groups at year 50 would be 30 percent for the Malheur National Forest, 27 percent for the Umatilla National Forest, and 21 percent for the Wallowa-Whitman National Forest. Within the dry upland forest potential vegetation group, the proportion of dry upland old forest single story at year 50 would be 12 percent for the Malheur National Forest, 13 percent for the Umatilla National Forest, and 9 percent for the Wallowa-Whitman National Forest.

Issue 5: Recommended Additions to the National Wilderness Preservation System

The same proposals made for Alternative E are made for Alternative F: 90,800 acres.

Issue 6: Ecological Resilience

Values for all key indicators for ecological resilience fall in the middle range among the alternatives.

Description of Alternatives Considered but Eliminated from Detailed Study

During the scoping period, the Blue Mountains Forest Plan Revision Team received a large number of comments on the proposed action. Many of those comments included specific requests for changes in management area allocations, goals and objectives, standards and guidelines, and monitoring requirements. Given the large area under consideration and the number of decisions being made, there are a large number of possibilities for combining different alternative components. Various components from the comments that were considered substantive were incorporated into the alternatives analyzed in detail, but some requests were not carried forward because they (1) closely resembled alternatives already considered in detail, (2) did not meet the purpose and need for forest plan revision, or (3) they were not appropriate for a forest plan decision.

Alternative G – Minimum Management Alternative

Some people desire an alternative that eliminates human uses and human induced impacts to the Blue Mountains national forests. In this alternative, there would be no vegetation management, no wildlife habitat improvements, no grazing permits, limited recreation use, and limited access to the national forests. This alternative was considered but not studied in detail because this level of management is already described in the Minimum Management Level Benchmark (available in the planning record). This alternative does not address all the identified issues and it would eliminate most of the multiple uses and benefits for which the national forests were created. With demonstrated demands for public access, recreation experiences, and forest products, elimination of these activities would conflict with current agency policy. Alternative C, which would substantially reduce the amount of human uses and activities, addresses these comments, within the constraints of the Forests' required multiple use management.

Alternative H – Elimination of Inventoried Roadless Areas

Some people desire an alternative that would release the areas in the inventoried roadless areas into general forest and make them suitable for timber production and road building. Inventoried roadless areas were evaluated and considered for allocation to preliminary administratively recommended wilderness areas (Management Area 1B) in accordance with 36 CFR 219.17. The results of the evaluation were considered during the analysis of the alternatives studied in detail and are disclosed in Chapter 3. Inventoried roadless areas within all three National Forests are allocated to management areas where their undeveloped character will be retained by restricting road construction and timber harvest. Additionally, in 2012, the Supreme Court retained the 2001 Roadless Area Conservation Rule which prohibits road construction, road reconstruction, and timber harvesting in inventoried roadless areas on National Forest System lands, with some exceptions (36 CFR 294, Subpart B). This ruling means that areas designated as inventoried roadless areas would retain certain protections regardless of what management area they fall under. For a full disclosure of the inventoried roadless areas and the management areas they fall under see the Recommended Wilderness Area Section in Chapter 3.

Alternative I – No Commercial Timber Harvest

A number of individuals and organizations asked for consideration of an alternative that would include no commercial timber harvest. Some of these comments suggested that vegetation treatments to meet habitat objectives would be acceptable to them, but not commercial timber sales. This alternative was considered but not studied in detail because it would not meet the legal requirements of the Multiple Use Sustained Yield Act and the National Forest Management Act which allow for commercial harvest of timber to provide for multiple uses and benefits of the national forests. All alternatives analyzed in detail include management areas where there would be no commercial timber harvest, such as wilderness areas, preliminary administratively recommended wilderness areas, and other special areas. Alternative C, which projects a relatively low amount of commercial harvest, addresses these concerns within the constraints of the Forest Service's mandate of multiple use management.

Alternative J – No Grazing Alternative

Among the comments were requests for analysis of an alternative that prohibits grazing. Both the Multiple-Use Sustained Yield Act of 1960 and the National Forest Management Act of 1976 require the Forest Service to provide for a variety uses, products, and services, including the grazing of rangelands, and, through forest planning, to determine the availability and suitability of lands for such purposes. Authorization of livestock grazing, and the stocking level decisions for specific grazing allotments are not made through forest planning, but rather through site-specific National Environmental Policy Act (1969) analyses. Grazing is authorized by term grazing permits. The Forest Plans define the desired outcomes and prescriptive measures (i.e., standards and guidelines that may influence grazing practices allowed by term grazing permits), but do not make decisions for livestock grazing use or capacity levels. The restrictions on grazing proposed for Alternative C, while not stating that grazing would be prohibited, would reduce the amount of domestic livestock grazing within the Blue Mountains national forests.

Alternative K – Unconstrained Budget Alternative

An alternative that assumes an unconstrained future budget was suggested. An unconstrained budget is inherently unrealistic and unreasonable. In addition, a forest plan does not influence or control the budget for a national forest. This alternative was eliminated from further study. Alternatives D, E, E-Modified, E-Modified Departure and F include some budget assumptions.

Alternative L – No Wildfire Use Alternative

Comments received suggested the Forest Service should consider an alternative that eliminates wildland fire use. The Forest Service national policy is to manage naturally ignited wildland fires to meet land management direction specified in the forest plan. Use of wildland fire allows the Forest Service to explicitly acknowledge when and where a naturally ignited wildland fire could create, enhance, or maintain desired conditions. As always, the overriding consideration in any response to a wildland fire remains firefighter and public safety. Many scientific studies have concluded that restoration of wildland fire as an ecological process is essential to land health. Therefore, this alternative was not analyzed in detail. There would be no objective for managed wildland fire for resource benefits in Alternative D.

Alternative M – Site-specific Travel Management Alternative

Some public comments requested that individual routes (roads and trails) or all unclassified routes be evaluated and decisions be made concerning their designation and use through the

revision process. A review of routes requires more site-specific analysis and more alternatives than would be practical during forest plan revision and is considered during travel management planning processes. A forest plan is strategic, identifying desired conditions, goals and objectives, standards and guidelines, and suitable uses.

Access has been identified as a significant issue and is discussed in this Final Environmental Impact Statement, but the analysis and decision to open or close specific routes or areas to motor vehicle access is a site-specific project-level analysis and is not within the scope of this Forest Plan Revision.

Alternative N – Other Management Indicator Species Alternative

The public requested that many species be considered as management indicator species. The purpose of management indicator species is to show effects of management actions. The designation does not infer a special degree of protection. Species selected as management indicator species can be monitored and a connection between habitat and management activities can be made. This connection cannot be made with most of the species suggested by the public and even most of those identified in the 1990 Forest Plans. The analysis of the current management indicator species is included in the analysis and description of Alternative A (No Action). The complete list of species considered and the rationale for those selected and not selected for other alternatives is available in the planning record. The Aquatic and Terrestrial Wildlife Species Diversity and Viability Sections discuss the management indicator and focal species identified for this planning effort and the predicted effects from each alternative.

Alternative O – No Herbicide Use Alternative

Some public comments asked that an alternative that eliminates the use of herbicides to contain, control, or eradicate invasive species be analyzed. Herbicides, along with prevention and manual control methods, are part of the range of tools available to contain, control or eradicate invasive species. Site-specific analyses at the project level, including risk assessments of any herbicides proposed for use, would determine the best method or combination of methods to safely and effectively manage invasive species in the Blue Mountains national forests. Alternatives A, B, C, D, E and F incorporate direction for the management of invasive species outlined in the Forest Service Pacific Northwest Region’s “Preventing and Managing Invasive Plants,” Final Environmental Impact Statement and Record of Decision (USDA Forest Service 2005).

Alternative P – Wilderness Area Emphasis Alternative

Some individuals and groups requested an alternative that allocates to preliminary administratively recommended wilderness areas all unroaded areas on the Blue Mountains national forests greater than 1,000 acres. However, many of these areas do not meet the Forest Service Handbook (FSH 1909.12 Chapter 70) (2007) criteria for inclusion in the inventory of areas with wilderness area potential. Alternative C, which would allocate more than 500,000 acres to preliminary administratively recommended wilderness areas (Management Area 1B), responds to the request to emphasize wilderness areas.

Alternative Q – Conformance with the Resource Planning Act

The National Forest Management Act regulations require development of at least one alternative that incorporates the Resource Planning Act Program’s tentative objectives for each national forest as displayed in Regional Guides (36 CFR 219.12(f)(6)). The last Resource Planning Act

Program was developed in 1995. Regional guides were eliminated in the 2000 Planning Rule (36 CFR 219.35). The Forest Service Strategic Plan for 2015-2020, in lieu of a Resource Planning Act Program, was completed in accordance with the Government Performance Results Act and the Interior and Related Agencies Appropriations Act. The Forest Service's 2015-2020 Strategic Plan does not recommend outputs to incorporate into specific forest plans, but all alternatives analyzed in detail incorporate the Forest Service's Strategic Plan's broad strategic objectives.

Comparison of Alternatives

This section provides tabular comparisons of how the alternatives, and their key indicators, differ for each national forest with respect to the issues identified during scoping and Draft Environmental Impact Statement comment periods. Alternatives also are compared for each forest by tabulation of acres (or miles) for each management area.

Issues Addressed

Tables 1, 2, and 3 display the comparison of how the alternatives respond to the issues to be addressed and the key indicators identified in Chapter 1 for each national forest based on the objectives identified for each alternative. The figures displayed for Alternative A represent the existing condition under existing Forest Plans. See Appendix A in Volume 4 for a detailed description of the alternatives, including the objectives.

Table 1. Issues and key indicators for each alternative for the Malheur National Forest

Key Indicator (Malheur NF)	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Issue 1: Access								
Miles of road maintained annually	1,152	1,136	235	1,604	1,313	1,313	1,313	1,313
Acres suitable for summer motor vehicle use	1,482,000	1,555,400	897,100	1,613,800	1,535,800	1,539,900	1,539,900	1,535,800
Acres suitable only for nonmotorized summer use	272,000	147,200	813,700	86,700	170,700	160,500	160,500	170,700
Acres suitable for winter over-the-snow vehicle use	1,575,500	1,556,600	1,067,000	1,616,000	1,568,400	1,542,100	1,542,100	1,568,400
Issue 2: Economic and Social Well-being	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Timber harvest jobs	170	243	86	761	447	451	717	313
Timber harvest income (thousands)	$9,932	$14,114	$5,003	$44,226	$26,014	$26,267	$41,756	$18,198
Livestock grazing jobs	426	435	204	432	426	460	460	426
Livestock grazing income (thousands)	$7,690	$7,875	$3,851	$7,814	$7,690	$8,296	$8,296	$7,690
Recreation jobs	48	48	48	48	48	48	48	48
Recreation income (thousands)	$1,270	$1,270	$1,270	$1,270	$1,270	$1,270	$1,270	$1,270
Timber volume planned for sale/TSPQ (MMBF/year)	32	45	16	141	83	84	134	58
Allowable sale quantity (MMBF/year)	59	75	40	128	75	80	80	75
Issue 3: Livestock Grazing and Grazing Land Vegetation	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Acres suitable for cattle grazing	1,197,000	1,225,000	620,000	1,216,000	1,197,000	1,318,000	1,318,000	1,197,000
Acres suitable for sheep grazing	102,000	101,000	55,000	101,000	101,000	101,000	101,000	101,000
Animal unit months (cattle)	117,000	120,000	61,000	119,000	117,000	126,000	126,000	117,000
Animal unit months (sheep)	6,500	6,500	1,200	6,500	6,500	7,200	7,200	6,500
Rate of progress towards achieving rangeland vegetation desired condition	slow to moderate	slow to moderate	fastest	slow	slow to moderate	moderate to fastest	moderate to fastest	slow to moderate

Key Indicator (Malheur NF)	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Issue 4: Old Forest								
Acres of old forest within management area allocations with limited management activity	78,000	81,000	350,000	73,000	85,000	79,000	79,000	85,000
Acres of timber harvest per year in old forest	500	800	0	4,800	1,600	2,200	2,600	1,000
Percent old forest at year 50 (all potential vegetation groups)	33	31	31	30	30	34	34	30
Percent dry upland forest old forest single story at year 50	13	11	10	16	16	19	20	12
Issue 5: Recommended Additions to National Wilderness Preservation System	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Acres of MA 1B	0	1,200	83,800	0	30,400	26,600	26,600	30,400
Issue 6: Ecological Resilience	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Annual forested vegetation active restoration activities (acres)	18,100	18,700	14,300	25,100	24,800	26,800	34,000	20,100
Miles of road treatments in priority watersheds	260	260	600	650	290	290	290	310
Forage use intensity in priority watersheds	15.9%	15.9%	3.8%	17.0%	15.9%	17.0%	17.0%	15.9%
Miles of riparian area improvement	300	300	600	300	450	410	420	400
Number of subwatersheds in improved condition	20	11	35	21	14	26	26	12
Vegetation departure index value in the dry upland forest potential vegetation groups at year 50	48	46	50	34	38	43	37	36

Table 2. Issues and key indicators for each alternative for the Umatilla National Forest

Key Indicator (Umatilla NF)	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Issue 1: Access								
Miles of road maintained annually	427	427	209	910	540	540	540	540
Acres suitable for summer motor vehicle use	934,200	1,053,200	556,700	1,068,700	975,200	986,700	986,700	975,200
Acres suitable only for nonmotorized summer use	460,200	350,900	871,200	330,200	440,400	411,800	411,800	440,400
Acres suitable for winter over-the-snow vehicle use	1,061,700	1,054,600	652,300	1,072,400	1,019,000	994,200	994,200	1,019,000
Issue 2: Economic and Social Well-being	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Timber harvest jobs	253	352	129	1,026	542	531	887	447
Timber harvest income (thousands)	$14,723	$20,453	$7,519	$59,647	$31,488	$30,871	$51,622	$25,985
Livestock grazing jobs	187	155	23	165	165	244	244	165
Livestock grazing income (thousands)	$2,653	$2,445	$301	$2,481	$2,481	$3,453	$3,453	$2,481
Recreation jobs	43	43	43	43	43	43	43	43
Recreation income (thousands)	$1,240	$1,240	$1,240	$1,240	$1,240	$1,240	$1,240	$1,240
Timber volume planned for sale/ TSPQ (MMBF/year)	27	37	14	108	57	56	94	47
Allowable sale quantity (ASQ) (MMBF/year)	34	48	24	90	48	53	53	48
Issue 3: Livestock Grazing and Grazing Land Vegetation	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Acres suitable for cattle grazing	284,000	298,000	30,000	284,000	284,000	284,000	284,000	284,000
Acres suitable for sheep grazing	60,000	28,000	13,000	42,000	42,000	42,000	42,000	42,000
Animal unit months (cattle)	30,000	31,000	3,000	30,000	30,000	39,000	39,000	30,000
Animal unit months (sheep)	7,800	4,600	1,200	5,800	5,800	10,200	10,200	5,800
Rate of progress towards achieving rangeland vegetation desired condition	slow to moderate	slow to moderate	fastest	moderate	moderate	fast	fast	moderate

Key Indicator (Umatilla NF)	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Issue 4: Old Forest								
Acres of old forest within management area allocations with limited management activity	142,000	188,000	322,000	176,000	191,000	181,000	181,000	191,000
Acres of timber harvest per year in old forest	300	500	0	2,900	1,000	700	900	500
Percent old forest at year 50 (all potential vegetation groups)	29	28	28	26	27	29	29	27
Percent dry upland forest old forest single story at year 50	15	12	11	14	15	18	19	13
Issue 5: Recommended Additions to National Wilderness Preservation System	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Acres of MA 1B	0	1,400	248,500	0	40,100	31,900	31,900	40,100
Issue 6: Ecological Resilience	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Annual forested vegetation active restoration activities (acres)	16,950	17,400	14,000	20,100	23,400	19,800	26,700	18,700
Miles of road treatments	260	260	450	800	300	300	300	270
Forage use intensity	11.4%	10.6%	0.8%	13.8%	10.6%	13.8%	13.8%	10.6%
Miles of riparian area improvement	150	150	300	150	225	215	220	210
Number of subwatersheds in improved condition	9	7	25	21	5	8	10	6
Vegetation departure index value in the dry upland forest potential vegetation groups at year 50	48	47	52	40	41	44	40	40

Table 3. Issues and key indicators for each alternative for the Wallowa-Whitman National Forest

Key Indicator (Wallowa-Whitman NF)	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Issue 1: Access								
Miles of road maintained annually	444	444	204	700	359	359	359	359
Acres area suitable for summer motor vehicle use	1,315,800	1,311,200	620,100	1,327,300	1,204,800	1,282,900	1,282,900	1,204,800
Acres suitable only for nonmotorized summer use	438,600	417,000	1,122,600	403,800	531,000	449,900	449,900	531,000
Acres suitable for winter over-the-snow vehicle use	1,369,200	1,322,000	870,400	1,335,000	1,232,800	1,290,600	1,290,600	1,232,800
Issue 2: Economic and Social Well-being	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Timber harvest jobs	185	279	103	978	596	611	910	388
Timber harvest income (thousands)	$10,308	$15,526	$5,708	$54,560	$33,238	$34,066	$50,812	$21,605
Livestock grazing jobs	282	264	112	292	274	379	379	274
Livestock grazing income (thousands)	$5,077	$4,820	$1,858	$5,262	$5,005	$6,959	$6,959	$5,005
Recreation jobs	53	53	53	53	53	53	53	53
Recreation income (thousands)	$1,245	$1,245	$1,245	$1,245	$1,245	$1,245	$1,245	$1,245
Timber volume planned for sale/TSPQ (MMBF/year)	20	30	11	104	63	65	98	41
Allowable sale quantity (ASQ)) (MMBF/year)	50	57	25	92	57	64	64	57
Issue 3: Livestock Grazing and Grazing Land Vegetation	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Acres suitable for cattle grazing	408,000	393,000	135,000	422,000	408,000	527,000	527,000	408,000
Acres suitable for sheep grazing	25,000	22,000	22,000	25,000	25,000	25,000	25,000	25,000
Animal unit months (cattle)	77,000	74,000	26,000	80,000	77,000	107,500	107,500	77,000
Animal unit months (sheep)	4,500	3,500	3,500	4,500	3,500	4,500	4,500	3,500
Rate of progress towards achieving rangeland vegetation desired condition	slow to moderate	slow to moderate	fastest	moderate	moderate	moderate to fastest	moderate to fastest	moderate

Key Indicator (Wallowa-Whitman NF)	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Issue 4: Old Forest								
Acres of old forest within management area allocations with limited management activity	144,000	152,000	290,000	143,000	153,000	123,000	123,000	153,000
Acres of timber harvest per year in old forest	200	300	0	2,900	700	900	1000	500
Percent old forest at year 50 (all potential vegetation groups)	22	21	21	20	21	23	23	21
Percent dry upland forest old forest single story at year 50	9	8	7	11	11	15	16	9
Issue 5: Recommended Additions to National Wilderness Preservation System	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Acres of MA 1B	0	10,800	172,700	0	20,300	12,000	12,000	20,300
Issue 6: Ecological Resilience	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. E-Modified**	**Alt. E-Modified Departure**	**Alt. F**
Annual forested vegetation active restoration activities (acres)	17,650	18,150	14,450	22,650	23,450	22,600	29,800	19,850
Miles of road treatments	260	260	400	800	300	300	300	270
Forage use intensity	12%	12%	3%	17%	12%	17%	17%	12%
Miles of riparian area improvement	250	250	500	250	375	375	350	350
Number of subwatersheds in improved condition	8	15	45	15	14	11	11	14
Vegetation departure index value in the dry upland forest potential vegetation groups at year 50	54	52	55	45	45	50	45	45

Management Areas

The following tables display the management area designations and allocations for each of the alternatives. The 1990 Forest Plans created a variety of management areas that are not consistent across the Blue Mountains national forests. A new management area identification scheme is used in this document. In order to compare alternatives, the existing management areas for each national forest were reclassified into this new scheme. Therefore, Alternative A is described using the same management area designations as Alternatives B through F.

All management areas acres are displayed in full. Overlap occurs between most management areas. The overlapping management areas result in the total acreage of all management areas being greater than the official national forest acreages. For example, several research natural areas (MA 2B) and wild and scenic rivers (MA 2A) overlap into congressionally designated wilderness areas (MA 1A).

For Alternatives B, C, D, E, E-Modified, E-Modified Departure, and F, the wilderness area acres have been recalculated for comparison purposes using the most current GIS technology. No additions or subtractions to any wilderness areas have been made since the 1990 Forest Plans were approved and signed. Acres of private land inclusions are not included in any wilderness area acre calculations, except where noted.

The figures in the tables are rounded to the nearest 100 (acres) or to the nearest whole mile except for Alternative A.

The management area acres table for the Malheur National Forest (Table 4) includes acres from the portion of the Ochoco National Forest administered by the Malheur National Forest.

The management areas acres table for the Wallowa-Whitman National Forest (Table 6) does not include the Hells Canyon National Recreation Area. Scenic byways and national designated trails within the national recreation area are not included.

The 1990 Forest Plans do not have management areas designated for recommended wilderness areas, eligible wild and scenic rivers, scenic byways and All-American Roads, or nationally designated trails. Individual national forests may recognize roads, trails and areas, but they were not designated as management areas in the 1990 Forest Plans (Alternative A).

Refer to the map packet for maps of the management areas for each national forest for each alternative.

Table 4. Management area designation, name, and acreage (miles for 2F and 2G) for each alternative for the Malheur National Forest

Management Area Designation and Name	Alt. A	Alt. B	Alt. C	Alt. D	Alts. E and F	Alts. E-Mod. and E-Mod. Departure
1A Congressionally Designated Wilderness Areas*	82,557	82,600	82,600	82,600	82,600	82,600
1B Preliminary Administratively Recommended Wilderness Areas	NA	1,200	83,800	NA	30,400	26,600
2A Designated and Eligible Wild and Scenic Rivers (does not include eligible wild and scenic rivers for Alternative A)	10,807	12,100	12,100	12,100	12,100	12,100
2B Research Natural Areas	8,114	11,100	11,100	11,100	11,100	11,100
2C Botanical Areas	30	100	100	100	100	100
2D Geological Areas	40	200	200	200	200	200
2E Historical Areas	NA	34,000	34,000	34,000	34,000	34,000
2F Scenic Byways and All-American Roads	NA	13 miles	13 miles	13 miles	13 miles	13 miles
2G Nationally Designated Trails	NA	9 miles	9 miles	9 miles	9 miles	9 miles
2H Scenic Areas	14,399	14,400	14,400	14,400	14,400	14,400
2J Municipal Watersheds	519	500	500	500	500	500
3A Backcountry (nonmotorized use)	47,535	59,300	270,400	NA	53,600	47,200
3B Backcountry (motorized use)	14,652	129,100	NA	165,800	119,100	118,000
3C Wildlife Corridor	NA	NA	167,700	NA	NA	NA
4A General Forest	851,877	1,252,000	702,500	1,359,800	1,245,600	1,250,200
4B Riparian Management Areas	88,593	149,900	172,400	66,000	148,800	192,900
4C Old Forest	84,232	NA	205,100	NA	NA	NA
4D Big Game Winter/ Summer Range	293,453	NA	NA	NA	NA	NA
4E General Wildlife/Fish	50,741	NA	NA	NA	NA	NA
4F Visuals	217,328	NA	NA	NA	NA	NA
5 Developed Sites and Administrative Areas	647	2,200	2,200	2,200	2,200	2,200

* The designated wilderness area acres displayed for Alternative A are taken from the 1990 forest plans and have not been recalculated using current technology. Private inclusions are included in the total for congressionally designated wilderness areas for Alternative A.

NA = not applicable

Table 5. Management area designation, name, and acreage (miles for 2F and 2G) for each alternative for the Umatilla National Forest

Management Area Designation and Name	Alt. A	Alt. B	Alt. C	Alt. D	Alts. E and F	Alts. E-Mod. and E-Mod. Departure
1A Congressionally Designated Wilderness Areas*	304,173	304,200	304,200	304,200	304,200	304,200
1B Preliminary Administratively Recommended Wilderness Areas	NA	1,400	248,500	NA	40,100	31,900
2A Designated and Eligible Wild and Scenic Rivers (does not include eligible wild and scenic rivers for Alternative A)	6,926	44,600	44,600	44,600	44,600	44,400
2B Research Natural Areas	11,224	11,000	11,000	11,000	11,000	11,000
2C Botanical Areas	817	2,400	2,400	2,400	2,400	900
2D Geological Areas	416	400	400	400	400	400
2E Historical Areas	1,178	1,200	1,200	1,200	1,200	1,200
2F Scenic Byways and All-American Roads	NA	51 miles	51 miles	51 miles	51 miles	51 miles
2G Nationally Designated Trails	NA	30 miles	30 miles	30 miles	30 miles	30 miles
2H Scenic Areas	31,109	31,100	31,100	31,100	31,100	31,300
2J Municipal Watersheds	12,581	20,200	20,200	20,200	20,200	20,200
3A Backcountry (nonmotorized use)	29,760	19,300	105,800	NA	70,100	49,700
3B Backcountry (motorized use)	11,909	240,900	NA	218,700	160,600	169,200
3C Wildlife Corridor	NA	NA	91,900	NA	21,600	NA
4A General Forest	296,180	640,300	329,000	742,300	625,200	648,000
4B Riparian Management Areas	69,776	118,700	178,100	58,100	116,100	237,500
4C Old Forest	44,277	NA	94,800	NA	NA	NA
4D Big Game Winter/Summer Range	130,215	NA	NA	NA	NA	NA
4E General Wildlife/Fish	430,166	NA	NA	NA	NA	NA
4F Visuals	65,775	NA	NA	NA	NA	NA
5 Developed Sites and Administrative Areas	4,922	3,700	3,700	3,700	3,700	7,500

* The designated wilderness area acres displayed for Alternative A are taken from the 1990 forest plans and have not been recalculated using current technology. Private inclusions are included in the total for congressionally designated wilderness areas for Alternative A.

NA = not applicable

Table 6. Management area designation, name, and acreage (miles for 2F and 2G) for each alternative for the Wallowa-Whitman National Forest

Management Area Designation and Name	Alt. A	Alt. B	Alt. C	Alt. D	Alts. E and F	Alts. E-Mod. and E-Mod. Departure
1A Congressionally Designated Wilderness Areas*	373,676	372,900	372,900	372,900	372,900	372,900
1B Preliminary Administratively Recommended Wilderness Areas	NA	10,800	172,700	NA	20,300	12,000
1C Wilderness Study Area	2,350	2,400	2,400	2,400	2,400	2,400
2A Designated and Eligible Wild and Scenic Rivers (does not include eligible wild and scenic rivers for Alternative A)	21,936	84,400	84,400	52,900	52,900	52,900
2B Research Natural Areas	2,635	8,000	7,255	8,000	7,255	8,000
2E Historical Areas	0	0	0	0	0	2,300
2F Scenic Byways and All-American Roads	NA	85 miles	85 miles	85 miles	85 miles	85 miles
2G Nationally Designated Trails	NA	25 miles	25 miles	25 miles	25 miles	25 miles
2I Starkey Experimental Forest and Range	27,251	30,500	30,500	30,500	30,500	30,500
2J Municipal Watersheds	NA	24,500	24,500	24,500	24,500	24,500
3A Backcountry (nonmotorized use)	NA	NA	210,100	NA	104,400	31,700
3B Backcountry (motorized use)	119,938	248,800	NA	219,500	145,500	209,400
3C Wildlife Corridor	NA	NA	242,600	NA	6,500	NA
4A General Forest	734,500	848,000	397,200	998,700	844,300	861,400
4B Riparian Management Areas	121,683	184,600	200,800	87,100	186,300	362,500
4C Old Forest	60,285	NA	91,000	NA	NA	NA
4D Big Game Winter/Summer Range	396,703	NA	NA	NA	NA	NA
4E General Wildlife/Fish	60,326	NA	NA	NA	NA	NA
4F Visuals	4,287	NA	NA	NA	NA	NA
5 Developed Sites and Administrative Areas	7,111	7,700	7,700	7,700	7,700	7,700

* The designated wilderness area acres displayed for Alternative A are taken from the 1990 forest plans and have not been recalculated using current technology. Private inclusions are included in the total for congressionally designated wilderness areas for Alternative A.

NA = not applicable

Chapter 3. Affected Environment and Environmental Consequences

Introduction

Chapter 3 describes the affected environment and environmental consequences from implementing the alternatives described in Chapter 2 and Appendix A (Volume 4) in relation to the significant and other issues described in Chapter 1. It also provides the reader with the affected environment and environmental consequences for each of the alternatives which include no action (Alternative A, the existing forest plans), a new proposed action (Alternative E-Modified), and six other "action" alternatives. The affected environment is discussed by resource, rather than in its own chapter, in order to facilitate the reader's understanding of the context of the environmental consequences that follow. Each resource has a brief introduction.

As required by the 40 CFR 1502.14, the resource specialist provides an explanation of the analysis methodology that was used in drawing their effects analysis. The Environmental Consequences section is grouped by each alternative or by the plan revision alternatives versus the No-action Alternative. This chapter touches on a variety of resources. The organization is structured around the issues and then by environment type.

The issues are:

1. Access
2. Economic and social well-being
3. Livestock grazing and grazing land vegetation
4. Old forest
5. Recommended wilderness areas
6. Ecological resilience

The environment types include:

1. Physical
2. Biological
3. Social environments

As required by 40 CFR 1502.23, the "Economic and Social Well-Being Environmental Consequences" section, provides a basis for the cost-benefit analysis of this work towards contributing to local economic stability. Watershed and soil resources are discussed under the physical environment. Appendix B, Volume 4 provides details on the legal regulatory compliance.

The Analysis Area

The analysis area includes the National Forest System lands administered by the Malheur, Umatilla, and Wallowa-Whitman National Forests, with one exception: the Hells Canyon National Recreation Area portion of the Wallowa-Whitman National Forest is not included (as discussed in Chapter 1). The analysis area for the Malheur National Forest also includes an adjacent portion of the Ochoco National Forest that is administered by the Malheur National

Forest's Emigrant Creek Ranger District. These national forests are collectively referred to as the Blue Mountains national forests.

The Analysis of Environmental Consequences

The National Environmental Policy Act of 1969 requires the analysis and disclosure of direct, indirect, and cumulative effects to the affected environment. Environmental consequences are interchangeable with effects. The analysis of these anticipated effects provides a basis for comparing alternatives and a method by which the interdisciplinary team, the public, and the responsible official can assess the consequences through time and in a particular geographic area.

Programmatic Analysis

The impacts addressed in a programmatic plan revision environmental impact statement reflect the environmental issues associated with the programmatic nature of the plan. Because these issues typically relate to environmental effects over a broad geographic and time horizon, the depth and detail of impact analysis is expected to be broad and general. The effects analysis will focus on the major impacts that might result in the long term if the plan is implemented, especially on those resources or factors that would be adversely impacted.

For estimating the effects at the programmatic forest plan level, the assumption has been made that the kinds and amounts of resource management activities described in the alternatives are reasonably foreseeable actions intended to move towards or achieve the goals and desired conditions. However, the specific location, design, and extent of such activities are generally not known at this time. As described in Chapter 1, project level decisions that actually implement the forest plan are made in the future on a site-specific basis. Therefore, the discussions here refer to the potential for the effect to occur and are in many cases only estimates. The effects analyses are useful when comparing and evaluating alternatives on a forest-wide basis, but are not intended to be applied directly to site-specific locations within the Blue Mountains national forests.

Direct effects are not analyzed in this programmatic document because the actions are not tied to a specific place or location. Land management plans typically do not have direct effects, as they generally do not authorize site-specific projects. Direct effects can only be analyzed on site-specific projects that would cause a specific action to occur in a particular time and location. Plans may prohibit some actions that might be taken or might not have otherwise been proposed; however, plans do not compel actions to be taken. Instead, plans influence what might or might not be proposed in the future, and the nature of those actions.

Indirect effects are caused by an action and occur later or are removed in distance. The effects of programmatic direction are generally indirect effects.

A **cumulative effect** is the effect of an action when added to the effects of other past, present, and reasonably foreseeable future actions, regardless of which agency or person undertakes the actions and regardless of who owns the land on which the other actions occur. The cumulative effects analysis integrates the actions and activities occurring on other national forests and lands of other ownership into a broader "landscape" analysis. The cumulative effects area includes all lands within the proclaimed boundaries of the three National Forests and the portion of the Ochoco National Forest that is administered by the Malheur National Forest. It also includes the Hells Canyon National Recreation Area, private, state, and other federally administered lands within and adjacent to the boundaries of the three National Forests.

The provisions of the 1982 Planning Rule include requirements to coordinate planning efforts with local land owners as well as related planning efforts of other Federal agencies, State and local governments, and Indian Tribes (1982 rule provisions 219.6(k) and 219.7(c)). The analysis compares relevant plans and policies to the alternatives developed for National forest System lands, and then describe what the “effects” would be at that multi-land ownership level. It also describes whether and how the effects of each alternative accrue cumulatively with the effects of the plans and policies reviewed. This review is focused on the long-term outcomes of these plans as they pertain to the broader landscape. The results of these reviews are displayed in the Forest Plans for the three National Forests. The reviews of those plans and policies are incorporated by reference.

This cumulative effects analysis does not attempt to quantify the effects of past human actions by adding up all prior actions on an action-by-action basis. There are several reasons for not taking this approach. First, a catalog and analysis of all past actions would be impractical to compile and unduly costly to obtain. Current conditions have been impacted by innumerable actions during the last century (and beyond) and trying to isolate the individual actions that continue to have residual impacts would be nearly impossible. Second, providing the details of past actions on an individual basis would not be useful to predict the cumulative effects of the proposed action or alternatives. In fact, focusing on individual actions would be less accurate than looking at existing conditions, because information about the environmental impacts of individual past actions is limited and one cannot reasonably identify each and every action during the last century that has contributed to current conditions. Focusing on the impacts of past human actions risks ignoring the important residual effects of past natural events, which may contribute to cumulative effects just as much as human actions. By analyzing current conditions, all the residual effects of past human actions and natural events are sure to be captured, regardless of which particular action or event contributed those effects. Finally, the Council on Environmental Quality issued an interpretive memorandum on June 24, 2005, regarding analysis of past actions, which states, “agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions.”

For these reasons, the assessment of current environmental conditions in the affected environment incorporates the combined effects of past actions. Ongoing and reasonably foreseeable future actions are addressed within the analysis in the environmental consequences sections. Because the existing Forest Plan for the three National Forests have an anticipated lifespan of 15 to 20 years, this analysis incorporates the effects of reasonably foreseeable future actions. When forest plan activities are considered within a context of climate change, an additional factor is added to the cumulative effects analysis.

The direct, indirect and cumulative effects analyses incorporate the data files that are available from the analysis file (referred to as the planning record).

Consideration of Climate Change

Changes in climate are affecting environmental processes on each of the three National Forests in the Blue Mountains with subsequent cumulative impacts affecting humans, plants, and animals in the area (Halofsky and Peterson 2017). Expected changes relative to present conditions include, but are not limited to: fluctuations in temperature, precipitation, and soil moisture; physical relocation for specific plant and animal species; earlier snow melt with peak and low flows occurring at different times than expected, and extended periods of droughts and rain events with the latter resulting in floods (Halofsky and Peterson 2017).

To understand the science of what is occurring better, a partnering endeavor between the Pacific Northwest Research Station, the Pacific Northwest Region of the Forest Service, the University of Washington, the Climate Impacts Research Consortium at Oregon State University, and the Forest Service (which specifically included studying areas within the three National Forests) was conducted over a two-year period, and resulted in a final report on climate change vulnerabilities in the three Blue Mountains national forests (Halofsky and Peterson 2017). The purpose of the study was to assess climate vulnerability within the Blue Mountains and find adaptation options for what were considered the most important resources for local ecosystems and communities. It was determined that effects of climate change on hydrology in the Blue Mountains will be especially significant in terms of impacts to the four resources selected for the three National Forests, which were water, fish, upland vegetation, and special habitats.

Relative changes in temperature, precipitation, and carbon dioxide concentrations have implications for the amount and seasonality of water availability. These influences consequently affect the geographic locations that are habitable by plant and animal species, species abundance, the productive capacity of natural and human systems, and risks to natural and human systems from extreme events, such as floods. Changes in hydrologic processes are also important because they determine water availability and how it must be stored (naturally and in human systems).

The report by Halofsky and Peterson (2017) conveys the following with regard to the Blue Mountains and the three national Forests:

> Global climate models project that the current warming trend will continue throughout the 21st century in the Blue Mountains. Compared to observed historical temperature, average warming is projected to be 2.4 to 3.1 °C by 2050 and 3.2 to 6.3 °C by 2100, depending on greenhouse gas emissions. Precipitation may increase slightly in the winter, although the magnitude is uncertain.
>
> The effects of climate change on hydrology in the Blue Mountains will be especially significant. Decreased snowpack and earlier snowmelt will shift the timing and magnitude of streamflow and decrease summer soil moisture; peak flows will be higher, and summer low flows will be lower. Pronounced changes in snow and streamflow will occur in headwater basins of the Wallowa Mountains, especially in high-elevation radial drainages out of the Eagle Cap Wilderness, with large changes occurring in the more northerly sections of the Umatilla and Wallowa-Whitman National Forests along the Oregon-Washington border. Mid-elevation areas where snow is currently not persistent (northern Blue Mountains, margins of Wallowa, Elkhorn, Greenhorn, and Strawberry Mountains) may become largely snow-free in the future.
>
> Projected changes in climate and hydrology will have far-reaching effects on aquatic and terrestrial ecosystems, especially as frequency of extreme climate events (drought, low snowpack) and associated effects on ecological disturbance (streamflow, wildfire, insect outbreaks) increase. Vulnerability assessment and adaptation option development for the Blue Mountains conclude the following:

Water resources and infrastructure—

Effects: Decreasing snowpack and declining summer flows will alter timing and availability of water supply, affecting municipal and public uses downstream from and in national forests, and other forest uses including livestock grazing, wildlife, recreation, firefighting, road maintenance, and instream fishery flows. Declining summer low flows will affect water availability during late summer, the period of peak demand (e.g., for irrigation and power supply). Increased magnitude of peak stream flows will damage roads near perennial streams, ranging from minor erosion to complete loss of the road prism, thus affecting public safety, access for resource management, water quality, and aquatic habitat. Bridges, campgrounds, and national forest facilities near streams and floodplains will be especially vulnerable, reducing access.

Adaptation options: Primary adaptation strategies to address changing hydrology in the Blue Mountains include restoring the function of watersheds, connecting floodplains, reducing drainage efficiency, maximizing valley storage, and reducing fire hazard. Tactics include adding wood to streams, restoring beaver populations, modifying livestock management, and reducing surface fuels and forest stand densities. Primary strategies for infrastructure include increasing the resilience of stream crossings, culverts, and bridges to higher peak flows and facilitating response to higher peak flows by reducing the road system and disconnecting roads from streams using methods that will maintain a safe transportation system and long-term access where needed. Tactics include completing geospatial databases of infrastructure (and drainage) components, installing higher capacity culverts, and decommissioning roads or converting them to alternative uses.

Fisheries—

Effects: Decreased snowpack will shift the timing of peak flows, decrease summer low flows, and in combination with higher air temperature, increase stream temperatures, all of which will reduce the vigor of coldwater fish species. Abundance and distribution of spring Chinook salmon (*Oncorhynchus tshawytscha),* redband trout/steelhead (*Oncorhynchus mykiss)* and especially bull trout (*Salvelinus confluentus*) will be greatly reduced, although effects will differ by location as a function of both stream temperature and competition from nonnative fish species.

Increased wildfire will add sediment to streams, increase peak flows and channel scouring, and raise stream temperature by removing vegetation.

Adaptation options: Primary strategies to address climate change threats to cold-water fish species include maintaining or restoring natural flow regimes and water temperatures to buffer against future changes, improving connectivity within stream networks so aquatic organisms can better access suitable habitats, and developing wildfire use plans that address sediment inputs and road failures.

Tactics include using watershed analysis to develop integrated actions for vegetation and hydrology, protecting groundwater and springs, restoring riparian areas and beaver populations to maintain summer base flows and maintain or reduce water temperatures, reconnecting and increasing off-channel habitat and refugia, identifying and improving stream crossings that impede fish movement, implementing engineering solutions to improve stream structure and flow, decreasing road connectivity, and revegetating burned areas to store sediment and maintain channel geomorphology.

Upland vegetation—

Effects: Increasing air temperature, through its influence on soil moisture, is expected to cause gradual changes in the abundance and distribution of tree, shrub, and grass species throughout the Blue Mountains, with drought-tolerant species becoming more competitive. Ecological disturbance, including wildfire and insect outbreaks, will be the primary facilitator of vegetation change, and future forest landscapes may be dominated by younger age classes and smaller trees. High-elevation forest types will be especially

> vulnerable to disturbance. Increased abundance and distribution of nonnative plant species will create additional competition for regeneration of native plant species.
>
> **Adaptation options:** Most strategies for conserving native tree, shrub, and grassland systems focus on increasing resilience to drought, low snowpack, and ecological disturbance (wildfire, insects, nonnative species). These strategies generally include managing landscapes to reduce the severity and patch size of disturbances, encouraging fire to play a more natural role, and protecting refugia. Tactics include using silvicultural prescriptions (especially stand density management) and fuel treatments to reduce fuel continuity, reducing populations of nonnative species, potentially modifying seed zones for tree species, and revising grazing policies and practices. Rare and disjunct species and communities (e.g., whitebark pine, aspen, alpine communities) require adaptation strategies and tactics focused on encouraging regeneration, preventing damage from disturbance, and establishing refugia.
>
> **Special habitats—**
>
> **Effects:** Riparian areas and wetlands will be especially vulnerable to higher air temperature, reduced snowpack, and altered hydrology. The primary effects will be decreased establishment, growth, and cover of species such as cottonwood, willow, and aspen, which may be displaced by upland forest species in some locations. However, species that propagate effectively following fire will be more resilient to climate change. Reduced groundwater discharge to groundwater-dependent ecosystems will reduce areas of saturated soil, convert perennial springs to ephemeral springs, eliminate some ephemeral springs, and alter local aquatic flora and fauna.
>
> **Adaptation options:** Primary strategies for increasing resilience of special habitats to changing climate include maintaining appropriate densities of native species, propagating drought-tolerant native species, maintaining or restoring natural flow regimes to buffer against future changes, and reducing stresses such as conifer encroachment, livestock grazing, and ungulate browsing. Tactics include planting species with a broad range of moisture tolerance, controlling nonnative species, implementing engineering solutions to maintain or restore flows, restoring beaver populations, reducing damage from livestock and native ungulates, and removing infrastructure (e.g., campsites, springhouses) where appropriate.

Halofsky and Peterson (2017) acknowledge that modeling options are abundant for scientists to select from with regard to precipitation in the Pacific Northwest. They suggest in their summary of Mote et al. (2013) there could be as little as no change in precipitation to as much as a wide variation.

> Averaging all the model outputs for annual precipitation, the projected future precipitation is close to no change from historical, with a wide range of projections. There is some indication and greater model agreement that summers will be drier in the future, although summers in the Pacific Northwest are already quite dry (Mote et al. 2013).

Trends in historical and projected changes in precipitation in the Pacific Northwest are less clear than for temperature. For example, precipitation in the Pacific Northwest has increased by 13 to 38 percent since 1900 and has shown substantial inter-annual and decadal variability during the 20th century (Mote 2003a). Littell et al. (2009a) showed that projected increases in annual precipitation for the Pacific Northwest vary considerably between models. Average model increases in precipitation relative to the period from 1970 to 1999 were 1.3, 2.3, and 3.8 percent for the 2020s, 2040s, and 2080s, respectively. Ranges in these model estimates were minus 9 to plus 12 (-9 to +12) percent, minus 11 to plus 12 (-11 to +12) percent, and minus 10 to plus 20 (-10 to +20) percent, respectively.

While temperature data in the Blue Mountains appears to track regional trends fairly well, regional averages in precipitation for the Pacific Northwest may differ from those in the Blue Mountains due to complex local terrain and the position of the Blue Mountains relative to prevailing air masses and storm tracks.

However, based on data for Blue Mountains (Oregon climate zone 8), average precipitation is lower since 1970 for every month except April, July, and August. Cool season (October through March) precipitation is lower by 14 percent; warm season precipitation (April through September) is lower by 2 percent; July and August precipitation is higher by 27 percent. Changes at individual stations within and near the Blue Mountains may vary greatly from these averages (Gecy 2010). The difference between observed changes in precipitation in the Blue Mountains and the Pacific Northwest region illustrate that climate changes are not homogeneous and that local differences in weather pattern, topography, and other factors that influence the distribution of precipitation may be important in future assessments of climate change response, particularly in the Blue Mountains.

April 1 snowpack has declined in mountainous regions across the West (Mote 2003b, Mote et al. 2005), with observed changes largely being attributed to elevated temperatures in both winter and spring (Hamlet et al. 2005, Stewart et al. 2005). Similar changes are observed in the Blue Mountains where all but 2 of 34 measuring stations have recorded declines in April 1 snowpack since 1970, with an average decline of 24 percent and a range of 5 to minus-73 percent (Gecy 2010). Snowpack declines are expected to continue across the Blue Mountains as temperatures throughout the region increase. Continued warming is expected to result in more winter precipitation falling as rain rather than snow and less winter snow accumulation. Watersheds in which runoff presently results from a mixture of rain and snow are likely to become rain dominated by 2100. These changes are projected to result in reduced peak spring streamflow, increased winter streamflow, and reduced late summer flow. In low elevation areas where winter temperatures are at the threshold of freezing, winter precipitation is expected to become increasingly dominated by rain instead of snow (Mote 2003b, Hamlet et al. 2005, and Mote et al. 2005), and winter streamflow will become higher and more variable (Elsner et al. 2010). Overall, earlier snowmelt and longer warm periods is expected to lead to a shift of peak river runoff to early spring or winter (Barnett et al. 2005). Streamflow projections suggest that there will be higher annual streamflow with lower summer flows and higher and more variable winter flows (Hamlet and Elsner 2010). In the Blue Mountains, all 16 measuring stations with streamflow records beginning prior to 1940 show an increase in March runoff, and most show decreased June runoff. Reduced summer streamflow has not yet been observed.

The projected increase in air temperatures and the resulting effect on snow pack and timing and magnitude of rainfall is predicted to have considerable impact on natural resources and their management in the region and in the Blue Mountains (for more detail, refer to specific resource sections in this chapter.) Further, higher temperatures result in more energy input to the biophysical environment and an increased ability of the atmosphere to hold moisture; hence, some weather events and extremes will become more frequent, more widespread, or more intense during the 21st century (Parry et al. 2007).

Climate Change Effects on the Terrestrial Environment

Significant impacts to terrestrial ecosystem structure and function are expected as a consequence of climate change. Climate-vegetation interactions are expected to produce a number of terrestrial ecosystem disturbance effects, including increased fire frequency and severity and increased

susceptibility to insects and diseases and invasive species. Within the region, increased summer temperature and decreased summer precipitation are projected to result in a doubling of the area burned by fire by the 2040s and a tripling by the 2080s. The probability that the total acreage burned by very large fires will exceed 2 million acres within the 11 western states in a given year is projected to increase from 5 percent (observed) to 33 percent by the 2080s. East of the Cascades, mountain pine beetles will likely reach higher elevations and pine trees experiencing stress from changing climatic conditions will likely be more vulnerable to infestations by beetles (Littell et al. 2009b).

Changes in the length of the growing season, the timing of bud break (phenology), and the availability of soil moisture are expected to produce large shifts (both positive and negative) in forest growth and mortality rates, forest floor decomposition, and species composition in forest ecosystems. There is correspondence between earlier spring green up and the early onset of spring snowmelt runoff in western North America (Cayan et al. 2001). For wildlife, changes in climate and vegetation will affect habitat (such as cover), reproductive success, and food and water availability. These impacts in turn will alter species assemblage, migration routes, and viability of populations, particularly rare species and large mammals that may have greater sensitivity to these ecosystem and climatic changes. Anticipated changes to wildlife include:

- The susceptibility of high elevation habitats and species dependent on snowpack (e.g., wolverine)
- Impacts on wetlands and associated species, especially those sensitive to water temperature (e.g., tailed frog)
- Phenological mismatch between migratory bird movements and their habitat

Changes are expected to happen more quickly than species' abilities to adapt, thus connectivity to allow movement of species will be critical (for more detail, refer to the Terrestrial Wildlife Diversity and Viability section in this chapter). Management strategies to increase the adaptive capacity of terrestrial ecosystems in the face of climate change include:

- Conserving species and habitats threatened directly or indirectly by climate change
- Enhancing landscape connectivity
- Reducing barriers to species movement caused by shifts in habitat distributions
- Reducing the risk of uncharacteristically severe fires and insect and disease disturbances
- Reducing the extent of nonnative invasive species and preventing future infestations

Climate Change Effects on the Aquatic Environment

Isaak et al. (2017) conducted the aquatic species portion of the 2017 Blue Mountains Climate Change Vulnerability Assessment. They assessed the potential impacts of climate change on aquatic habitats for four important native aquatic species in the Blue Mountains: spring Chinook salmon (*Oncorhynchus tshwaytscha*), bull trout (*Salvelinus confluentus*), summer steelhead (*Oncorhynchus mykiss*) and interior redband trout (*Oncorhynchus mykiss gairdneri*). These species were selected due to the wide range of streams and rivers used by these species in aggregate in the Blue Mountains, as well as concerns for their long-term viability in subbasins where their habitats are affected by land management activities (such as timber production, livestock grazing, construction and management of the road network in particular) within National Forest System lands in the planning area.

Isaak et al. (2017) applied species-specific life history factors in their analysis to assess climate change implications for the selected species and their habitats. Implications for individual species are discussed in the "Aquatic Species Diversity and Viability" section of Chapter 3 in Volume 2, with full details on methods and species-specific findings provided in Isaak et al. (2017), which Halofsky and Peterson (2017) summarized as follows:

> Although habitats for the selected species overlap in places, each species uses a unique set of aquatic habitats in the Blue Mountains national forests and their associated subbasins, depending on their life stage, season of the year, and available habitat conditions. These species have a diverse array of life history strategies, including anadromy (steelhead and spring Chinook salmon), fluvial and adfluvial movements (bull trout), and residency (bull trout and redband trout).
>
> Climate change affects the environments of these species in many ways. Warming air temperatures and changing precipitation patterns are resulting in warmer stream temperatures (Bartholow 2005; Isaak et al. 2010, 2012b; Petersen and Kitchell 2001), altered stream hydrology (Hamlet and Lettenmaier 2007, Luce et al. 2013), and changes in the frequency, magnitude, and extent of climate-induced events such as floods, droughts, and wildfires (Holden et al. 2012, Littell et al. 2010, Luce and Holden 2009, Rieman and Isaak 2010). Fish populations have been adapting by shifting their phenology and migration dates (Crozier et al. 2008, 2011; Keefer et al. 2008), using cold water refugia during thermally stressful periods (Keefer et al. 2009; Torgersen et al. 1999, 2012), and shifting spatial distributions within river networks (Comte et al. 2013, Eby et al. 2014). These changes are adding additional stressors to many fish populations, but many populations are also likely to have sufficient resilience and habitat diversity to make the necessary adjustments."

Carbon Sequestration and Mitigation of Greenhouse Gas Emissions

Ecosystems are affected not only by climate change but also through carbon sequestration (e.g., plant growth) and greenhouse gas emissions (e.g., fire, organic matter decomposition, and soil respiration). Ecosystem functions also directly influence the global carbon cycle. The Forest Service administers roughly one-fifth of all U.S. forestland, and management of these forests can substantially affect total national forest carbon stocks (Heath et al. 2011). Consequently, the "Forest Service Roadmap for Responding to Climate Change" (USDA Forest Service 2010) identified assessing and managing carbon stocks as a part of the strategy.

Forest management can offset greenhouse gas emissions by increasing capacity for carbon uptake and storage in biomass, wood products, and soils. In general, while deforestation is a large global source of carbon dioxide, forestland area the United States has declined only slightly, and the forestry sector is in fact a net greenhouse gas sink (USDA Forest Service 2008). Forests of the Blue Mountains currently store substantial carbon stocks, and those levels have remained steady from 2005 to 2013 (USDA Forest Service 2015). Factors that could potentially influence whether carbon stocks eventually shift from regional carbon sinks to carbon sources include increasing temperatures, changes in precipitation, changing disturbance regimes (such as more frequent fires), and degradation of forest resiliency that results in net decreases of forested areas.

Consequently, the different approaches represented in the plan revision alternatives could have long-term implications in terms of the potential for carbon sequestration, although both the magnitude and direction of these changes to the carbon sink over the next 50 years are uncertain. Strategies that emphasize active management to increase forest resilience and retain forests,

would rely on activities such as thinning to reduce risk of stand-replacing wildland fire or insect disturbances, or to reduce moisture stress on the remaining trees. These treatments may reduce carbon stocks in the short term, but can have long-term benefits for carbon sequestration (Zhang et al. 2010). Management approaches designed to increase carbon storage by reducing harvest levels or lengthening harvest intervals involve uncertainty because disturbances would be more likely to occur in forests with higher carbon stores, and the risk of deforestation may increase in the long term. Carbon is also stored in wood products that are harvested from Pacific Northwest forests, but wood products are unlikely to provide for substantial increases in stored carbon under current manufacturing, use, and disposal practices. Rangeland carbon stocks are lower than forests and are less directly affected by rangeland management practices than timber harvests in forestlands (U.S. EPA 2011).

Adaptation to Climate Change

All forest plan alternatives include outcomes or allow for management actions that would improve the ability of the Blue Mountains national forests to adapt to a changing climate. The alternatives vary in the amount of outcomes and types of actions that are likely to occur. Forest plan components appropriate for addressing climate change include the following:

- Conserving species and habitats threatened directly or indirectly by climate change, enhancing landscape connectivity, and reducing barriers to species movement to facilitate the ability of species to move across the landscape with shifts in habitat distributions (desired conditions 1.1, 1.2, 1.7, and 1.12 and objectives 1.1 and 1.2)
- Reducing the risk of uncharacteristically severe fires and insect and disease disturbances through forest thinning (desired conditions 1.4.1, 1.4.2, 1.7, and 1.8 and objectives 1.1, 1.4.1, 1.4.2, 1.6, and 1.8)
- Reducing the risk of increased nonnative species infestations through reductions in the extent of current nonnative species and prevention of future infestations (desired condition 1.5 and objective 1.5)
- Reducing potential increases in stream temperatures through riparian buffers and stream restoration and maintenance of effective stream shade (desired condition 1.1 and objective 1.1)
- Reducing risk of water quality degradation while increasing aquatic connectivity by decreasing road density, reducing hydrological connectivity of the road system, replacing culverts, and road closure, realignment or obliteration (desired condition1.1 and objective 1.1)

The referenced forestwide desired conditions and objectives are described in more detail in Appendix A, Volume 4.

These various management approaches, as well as broader strategies and tactics described in Halofsky and Peterson (2017), when considered and implemented at the project level should result in landscapes that are more resistant to catastrophic wildland fires and insect and disease disturbances; are more resilient in the wake of extreme weather events; and are better able to adapt to changing conditions.

Climate change adaptation and effects vary by alternative, and are discussed in detail in the individual resource sections in this chapter.

Addressing Uncertainty through Adaptive Management

The effects of climate change on ecosystem structure and function and the effectiveness of management activities in climate adaptation are just two of many uncertainties in natural resource management. At this point, much of what is understood about climate change is based on models that are built on the best available scientific information and assumptions. There is relatively less direct experience observing how climate change is playing out in its effect on ecosystems, how management actions may help ecosystems adapt to a changing climate, and how model assumptions compare to reality. Varying levels of uncertainty still remain across climatic variables, across spatial and temporal scales, and across management objectives. For example, within the region, trends in warming temperatures, declining winter snow packs, and earlier spring snowmelt are relatively clearer than trends in precipitation. Further, it is challenging to interpret local variations in precipitation within the context of regional long-term trends.

Adaptive management is an approach for testing assumptions and reducing uncertainty over time. Monitoring is an important element in the evaluation climate effects on terrestrial, riparian, and aquatic ecosystems that can provide the basis for adapting management actions. Monitoring questions incorporated into the Forest Plans are designed to aid in the evaluation of assumptions regarding the interactions between climate, ecosystem structure and function, disturbance regimes, and outcomes of forest management. The results of local and regional monitoring, in conjunction with the best available scientific information, can be used to adjust management assumptions so that the forests are positioned to continually improve national forest management in a changing climate.

Using an adaptive management approach, as outlined by Williams et al. 2009, can assist land managers to address areas of uncertainty when planning foreseeable activities on public lands. In their sequential approach, two phases and several steps are required before implementing projects on the ground. They include:

Set-Up Phase

Step 1-Stakeholder Involvement

Involving stakeholders builds support for the process and provides a foundation for learning-based resource management.

Step 2 - Objectives

Identify clear, measurable, and agreed-upon management objectives to guide decision making. Because they can change through time as the resource system changes and stakeholder values evolve, it is useful to revisit objectives periodically.

Step 3 - Management actions

Identify a set of potential management actions for decision making, allowing them to flexible enough to grow with potential learning rates in the project and remember that stakeholder perspectives, resource conditions change, legal requirements change, and new information will become available as time evolves.

Step 4 - Models

Identify models that characterize different ideas (hypotheses) about how the system works for ecological understanding, for deductive inference, and as articulations of resource response to management and environmental change.

Step 5 - Monitoring plans

An effective and useful monitoring plan is required to test relevant assumptions and track changing conditions to reduce uncertainty, which is key to successful adaptive management.

Iterative Phase

Step 6 - Decisionmaking

Select management actions based on management objectives, resource conditions, and enhanced understanding throughout the project as learning accumulates and/or as the resource system responds to either environmental conditions or management actions. This can be crucial phase, i.e., deciding to reopen a grazing pasture when it has been determined that it has been recovered from a wildfire, etc.

Step 7 - Follow-up monitoring

Use monitoring to track system responses to management actions. Post-decision monitoring data can be folded into analysis/assessment before the next decision point, so that decision making at that time can take advantage of updated information and understanding.

Step 8 - Assessment

This is a key step in the adaptive management process. Land managers need to consider the accumulation of understanding and subsequent adaptation of management strategy (ies) from the results they have gathered and feed this information back into the decision making process. Improved understanding of resource dynamics can then be applied by comparing predicted vs. observed changes for selected resources.

Step 9 - Iteration

Cycle back to step 6 and, less frequently, to step 1.

The results gathered from the adaptive management approach suggested above can be, with supporting documentation considered to be best science available to support on the ground conditions for the Blue Mountains national forests.

Fundamentally, managing to restore and maintain ecosystem resilience to change is a key Forest Plan Revision Strategy. Information to begin forming models and assumptions can be gleaned from reports such as those provided for the Blue Mountains national forests by Halofsky and Petersen (2017).

Significant Issues

Issue 1: Access

Access to the national forests, including access for recreation, administrative use, permitted activities, valid existing rights, and firefighting, was identified as a significant issue during scoping. The issue involves road and trail access for motor vehicles, road access for managing resources, the cost of maintaining the transportation system, and the desire to reduce motor vehicle route density to improve fish and wildlife habitat and to protect streams. Access is analyzed and discussed in terms of whether an area is generally suitable or unsuitable for motor vehicle and nonmotorized uses.

An additional aspect of areas that would be generally suitable or unsuitable for motor vehicle use is the social response to these designations. Conflicts between users may be minimized by having areas that are clearly designed and designated for either motor vehicle use or nonmotorized use.

While the forest plan does not change designations of roads and trails for motor vehicle use, it would provide direction for future planning. Specifically, the forest plans include plan components and suitability ratings (see general suitability matrix for management areas in Appendix A, Volume 4 and the Revised Forest Plan) that identify where motor vehicle use is identified as either suitable or nonsuitable, and where road and trail construction is rated suitable or nonsuitable for each management area. The suitability ratings generally align with existing uses on the national forests. These plan components and suitability ratings, along with the recently completed Travel Analysis Reports for the Malheur, Umatilla, and Wallowa-Whitman National Forests, will help inform future project-level decisionmaking regarding the national forests' transportation system. Proposed open route densities for all alternatives are meant to be an upper limit, and all alternatives have many areas that would have open routes at a level that is far below the proposed upper limits. It is not the intent of the plan to increase open route density to that upper limit.

Motor vehicle access is desired for hunting and fishing, summer and winter recreation, private land access, management activities, and wildland fire suppression. Nonmotorized areas are desired for hunting and fishing, summer and winter recreation, secluded wildlife habitat, and biological reserves. The number of acres suitable for motor vehicle use and the desired conditions for road density in those areas will influence the future transportation system and future road management opportunities. The amount and type of access to an area is an important factor affecting the health of terrestrial, aquatic, and riparian habitats.

The amount and type of access available within the national forests affects recreation, wildlife, fisheries, and watershed resources, which is discussed in more detail in the corresponding resource sections. The focus of this section is access to the national forests for all uses. The amount of area within each national forest that is generally suitable for motor vehicle use (summer and winter) varies by alternative and is one measure of the differences between alternatives.

Identification of an area as generally suitable or generally unsuitable for a use guides future project and activity decision making. For example, if an area that is suitable for motor vehicle use in the 1990 Forest Plans is determined to be unsuitable for that use in the Revised Forest Plans, the new determination would not result in the immediate closure of roads in that area. Rather, that suitability determination would be considered in making future project level decisions. Those site-specific decisions may include road closures in that particular area. An area determined to be unsuitable for motor vehicle use is expected to have no future road or motor vehicle trail construction.

In 2005, the Forest Service published the travel management rule, covering the use of motor vehicles on National Forest System lands. The Code of Federal Regulations Title 36, Part 212 contains three subparts that provide direction for travel management in national forests. Subpart A stipulates the administration of national forest transportation systems and includes how road systems are to be managed. In 36 CFR 212.5 (b) the responsible official must identify the minimum road system needed for safe and efficient travel and for the administration, utilization, and protection of National Forest System lands. This requires a science-based roads analysis at the appropriate scale involving a broad spectrum of interested and affected citizens, state and

Federal agencies, and Tribal governments. The minimum system is the road system determined necessary to meet resource and other management objectives adopted in the relevant land and resource management plan (36 CFR part 219) to meet applicable statutory and regulatory requirements, to reflect long-term funding expectations, and to ensure that the identified system minimizes adverse environmental impacts associated with road construction, reconstruction, decommissioning, and maintenance. The forest plan revision will help inform this Subpart A requirement.

The travel management rule (36 CFR part 212, Subpart B) requires each administrative unit or ranger district to designate those National Forest System roads, National Forest System trails, and areas of National Forest System lands that are open to motor vehicle use by vehicle class and, if appropriate, by time of year. The travel management rule also requires designated roads, trails, and areas to be identified on a motor vehicle use map. After designated roads, trails, and areas have been identified on a motor vehicle use map, motor vehicle use inconsistent with those designations would be prohibited by 36 CFR 261.13.

In 2005, the agency regulated winter motorized use as a discretionary activity under its regulations for Use by Over-Snow Vehicles. Consistent with a court order dated March 29, 2013, the United States Department of Agriculture amended their Travel Management Rule to require designation of roads, trails, and areas on National Forest System lands to provide for over-snow vehicle use. These requirements are outlined under Subpart C of the Travel Management Rule.

The travel management rule combines regulations governing administration of the national forest transportation system and regulations covering the use of motor vehicles off National Forest System roads. The travel management rule implements Executive Order 11644 (February 8, 1972) “Use of Off-Road Vehicles on the Public Lands,” as amended by Executive Order 11989 (May 24, 1977).

The forest plan revision process does not include determinations for whether or not specific roads and trails will be constructed, maintained, closed, or decommissioned. The primary ways that the transportation system is managed during a plan period are by goals and desired conditions, including open motor vehicle route density, and the general suitability of an area for motor vehicle use or, conversely, the general suitability of an area for nonmotorized use only. Decisions on motor vehicle access are made through individual project planning and are reflected on the individual national forest’s motor vehicle use map. When the forest plans were approved in 1990, cross-country motor vehicle travel was prohibited within much of the Umatilla National Forest. The remaining area that was open to cross-country motor vehicle travel was closed in 2010. In contrast, the 1990 forest plans for the Malheur and Wallowa-Whitman National Forests did not prohibit cross-country travel, unless an area was closed by order.

Changes Made Between the Draft and Final Environmental Impact Statements

Aside from the global changes throughout this environmental impact statement described in the Preface to this document, the following changes were made specifically to this section:

Revised Forest Plan Content: In response to public comments that expressed a desire to not use the terms or phrases “designated routes” and “no cross country travel” from the draft forest plans and environmental impact statement, the documents were edited to remove the referenced language. Instead, this language was replaced with an acknowledgement that national forests are required to comply with existing forest service regulation, and in this particular instance, the

regulations at 36 CFR 212 that implement the Forest Service Travel Management Rule (2005). This acknowledgement responds to other public comments expressing a desire for the Forest Service to enforce compliance with regulations for off-highway vehicle use.

Based on internal Forest Service reviews, the public comments received on the 2014 Draft Revised Forest Plan, and the information gathered during public engagement sessions, management areas were refined and modified. The resulting review and management area allocations provide opportunity for increased motorized vehicle use, compared to the preferred Alternative E within the 2014 draft Forest Plan for the three National Forests. The increase results from changes to Management Areas 1B, 3A, 3B, and 4A. Conversely, the changes may slightly reduce the opportunity for nonmotorized experiences across the three National Forests.

In response to numerous comments on the Draft Revised Forest Plan and environmental impact statement that expressed concerns over natural resource protection, additional standards were developed for key watersheds and Rocky Mountain elk. These standards (KW-1S and RME-1S, 2S, and 3S) are interrelated with the forest transportation systems for the three National Forests. The combined effect of implementing these standards would likely reduce the size of the forest transportation systems, and could reduce motorized access. Additional site-specific analysis will better determine the location and magnitude of effect. See the related sections for more detail and analysis.

Access – Affected Environment

Access to the Malheur, Umatilla, and Wallowa-Whitman National Forests is provided by a complex and integrated transportation system of roads and trails managed by the Forest Service, county, state, and private jurisdictions. National Forest System roads range from two-lane paved highways to narrow, native-surface roads. The entire road system for all three National Forests includes more than 22,000 miles of roads. Roads are an important part of the infrastructure in the Blue Mountains national forests and provide access for recreation activities, timber removal, grazing, and wildfire protection, and access to facilities operated under special use authorizations. However, roads also have the potential to adversely affect a number of resources in various ways. In this analysis roads and motorized use trails are collectively referred to as routes.

The information for this analysis was acquired from agency documentation of historical maintenance funding and practices, as well as the agency database of record for the transportation system (called INFRA).

Access via roads and trails to and across the national forests has a long history in the Blue Mountains. Trails and migration routes date back to prehistoric times. American Indian migration routes are well documented through the stories of the Nez Perce, Umatilla, Warm Springs, and other Tribes. Many of these ancient routes are the basis for roads, portions of roads, or trails that are in use today. Trails within the national forests also contributed to western migration as expeditions passed through this area in the 1800s. Notable ones include the original Oregon Trail, portions of which can be traced along its original alignment.

The history of development for the road system on the Blue Mountains national forests is primarily related to extractive resource management activities such as mining and logging. Many roads were located directly adjacent to streams and rivers for ease of construction and to provide access to land for uses associated with water such as placer mining, cattle watering, water diversion, and log floating to sawmills. Lode mining necessitated the construction of roads and

railroads to haul ores. Logging operations provided necessary building materials for mining activities and often required additional roads.

Prior to the development of an extensive state highway road system, railroads provided primary access into the Plan Area. Railroad logging can be traced as far back as 1901, and signs of this activity remain today as evidenced by the numerous railroad grades throughout the area. Some railroad grades were later converted to vehicle roads. Additional roads were constructed to connect communities and for fire management and administrative access to the Forests. Once constructed, roads provided access for other uses, including viewing scenery, camping, hunting, grazing, and gathering forest products, such as berries and firewood.

Many trails on the national forests evolved from game trails, early American Indian hunting trails, and livestock herding trails, or those that were constructed by early recreation users. These trails were constructed to access remote lakes and scenic viewpoints. The majority of national forest trails are in dispersed and backcountry recreation areas.

In the 1990s, widespread adoption of off-highway vehicle use by the public significantly altered forest recreational access. Recreationists began to use off-highway vehicles to access areas which had previously been accessible only by foot or horseback and to access low maintenance level forest roads that had been inaccessible to most conventional vehicles. This expanded type of access resulted in increased resource impacts, conflicts between user groups, safety concerns, and competing public pressure regarding off road travel.

New, permanent road construction has markedly declined, and the current transportation system includes a backlog of maintenance needs. Currently, new road construction ranges from 0 to 3 miles, reconstruction ranges from 5 to 35 miles, and decommissioning ranges from 0 to 12 miles, all annually, for each of the three National Forests. Roads are reconstructed for a number of purposes, including improving road conditions, driver safety, and mitigating resource impacts. Road decommissioning occurs when a road is no longer needed for resource management and is minimally used by the public. Road decommissioning terminates motor vehicle use and restores ecological processes interrupted or impacted by the road. Roads are also decommissioned when maintenance requirements and resource impacts outweigh access needs.

Forest plans have components that guide decision-making to manage the transportation system on the three National Forests. These forest plan components include desired conditions for the road system, including desired conditions for open motor vehicle route density; suitability determinations for management areas where motor vehicle use, and road and trail construction is generally suitable or unsuitable; objectives for managing the transportation system to move towards achieving the desired conditions; and standards and guidelines to prevent environmental impacts when road maintenance, construction, or reconstruction is performed. Forest plans do not make decisions regarding individual roads or trails. This section describes the current transportation system on the three National Forests, how the alternatives address the different plan components that would guide future management, and what the effects to access would be from implementing those plan components.

The Blue Mountains national forests trail system has remained relatively unchanged for the past 20 years. Reconstruction of trails depends on funding and ranges from zero to 40 miles a year. Trail systems are rarely decommissioned.

Combining motor vehicle use and nonmotorized use at trailheads and along travel routes results in occasional conflicts, and contributes to access issues for each user group. As stated in the

Recreation section, some trail maintenance issues have been resolved through project-level activities using American Recovery and Reinvestment Act funds. At the national scale, the National Forest System Trails Stewardship Act (Public Law No. 114-245) will help establish a national strategy to significantly increase the role of volunteers and partners in trail maintenance, measures that may assist with continued trail maintenance needs and help address a backlog of trail maintenance. There are relatively limited opportunities for motor vehicle use on system trails throughout the Blue Mountains national forests, a limitation that poses additional challenges considering this type of use is increasing both locally and regionally.

Trails used primarily for foot, pack or riding stock, and mechanized transportation (bicycles) have occasional conflicts between users. Trails for snowmobiles, Nordic skiers, snowshoers, and dog sleds are designated on existing National Forest System roads and contribute to the winter recreation opportunities offered within the national forests. The following table displays the distribution of opportunities across the three National Forests. Recreation opportunities within the Hells Canyon National Recreation Area (Wallowa-Whitman National Forest) are not included in the following table.

Table 7. Route and trail miles by type and season of use for each national forest (existing condition/1990 forest plans based on 2009 data)

National Forest	Motor Vehicle Use Routes (miles in winter)	Nonmotorized Use Routes (miles in winter)	Motor Vehicle Use Trails (miles in summer)	Nonmotorized Use Trails (miles in summer)
Malheur	771	55	37	465
Umatilla	139	31	464	1,246
Wallowa-Whitman	896	80	138	860

Across the Blue Mountains national forests, trails are in a variety of management configurations. In some locations, summer nonmotorized trails are in areas that allow only nonmotorized use (such as wilderness areas). In other places, summer nonmotorized trails are in an area that can also be managed for motor vehicle trails, in addition to roads and other uses. Winter recreation facilities and routes are frequently associated with road systems. Snowmobile routes are almost entirely on road systems, because the width of the route allows for grooming equipment to pass through. Snowmobilers may opt to ride only the groomed routes because they enjoy that kind of riding, or they may select cross country travel that provides access to preferred areas. Nonmotorized winter routes are located in management areas that allow for motor vehicle use and in areas that allow only nonmotorized use (such as wilderness areas and recommended wilderness areas).

Road Maintenance Levels

Road maintenance level (ML) is defined as the level of service provided by, and maintenance required for, a specific road, consistent with road management objectives and maintenance criteria (FSH 7709.58, Sec 12.3 - Transportation System Maintenance Handbook). The handbook serves as a primer for how the transportation system is managed and maintained. In general, road maintenance objectives are categorized into five levels designated ML1 to ML5. Each maintenance level and its associated characteristics and management strategy are described below.

Maintenance Level 1 - Assigned to intermittent service roads during the time they are closed to vehicular traffic. The closure period must exceed 1 year. Basic custodial maintenance is performed to keep damage to adjacent resource to an acceptable level and to perpetuate the road to facilitate future management activities. Emphasis is normally given to maintaining drainage facilities and runoff patterns. Planned road deterioration may occur at this level. Roads receiving level 1 maintenance may be of any type, class or construction standard, and may be managed at any other maintenance level during the time they are open for traffic. However, while being maintained at level 1, they are closed to vehicular traffic, but may be open and suitable for nonmotorized uses.

Maintenance Level 2 - Assigned to roads open for use by high clearance vehicles. Passenger car traffic is not advised or possible. Traffic is minor, usually consisting of one or a combination of administrative, permitted, dispersed recreation, or other specialized uses. Log haul may occur at this level.

Maintenance Level 3 - Assigned to roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not considered priorities. Roads in this maintenance level are typically low speed, single lane with turnouts and spot surfacing. Some roads may be fully surfaced with either native or processed material.

Maintenance Level 4 - Assigned to roads that provide a moderate degree of user comfort and convenience at moderate travel speeds. Most roads are double lane and aggregate surfaced. However, some roads may be single lane. Some roads may be paved and/or dust abated.

Maintenance Level 5 - Assigned to roads that provide a high degree of user comfort and convenience. Normally, roads are double-lane, paved facilities. Some may be aggregate surfaced and dust abated.

Roads may be currently maintained at one level and planned to be maintained at a different level at some future date. The operational maintenance level is the maintenance level currently assigned to a road considering today's needs, road condition, budget constraints, and environmental concerns.

Key Indicators for Analyzing Access

- Road maintenance funds projected to be available to maintain the transportation system
    - ♦ Projected road maintenance for each road maintenance level (miles)
- National Forest System lands that would be suitable for motor vehicle route designation and use or suitable only for nonmotorized use (acres)
    - ♦ Change in acres suitable for summer motor vehicle route designation and use
    - ♦ Change in acres suitable only for summer nonmotorized use (where motor vehicle use would be prohibited)
    - ♦ Change in area suitable for winter over-the-snow motor vehicle use

Access – Environmental Consequences

Road Maintenance (Alternative A)

Key Indicator

- Road maintenance funds projected to be available to maintain the transportation system
  - ♦ Projected road maintenance for each road maintenance level (miles)

Maintenance of the transportation system is not sustainable given the current funding of the Forest Service. Table 8 indicates that the majority of the road maintenance budget is utilized on the double-lane passenger vehicle roads, which are the most expensive and most highly traveled portions of the road system. It is important to understand that some roads require annual maintenance while other roads, due to the stability of the roadbed, are rarely maintained. The figures are calculated using past maintenance and management costs, which fluctuated from year to year. When high clearance and closed roads receive maintenance on such an infrequent interval, deferred maintenance issues can become exacerbated. With the maintenance focus on maintenance levels (MLs) 3 through 5 roads, the deferred maintenance backlog for the remainder of the road system continues to grow. The cost of road maintenance and the budget trend make it likely that future road maintenance and management will continue to be challenging.

Table 8. Average annual road maintenance appropriated expenditures for the Blue Mountains national forests (existing condition/1990 forest plans)

Road Maintenance Level (ML)	Miles of Roads in Blue Mountains national forests	Average Maintenance Interval (years)	Annual Road Maintenance Cost (per mile)	Average Annual Cost ($)
Double lane passenger vehicle roads (MLs 4 and 5)	676	2	$2,615	$ 883,870
Passenger vehicle roads (ML 3)	714	3	$1,607	382,466
High clearance vehicle roads (ML 2)	12,330	10	$291	358,803
Custodial care (closed roads)	9,701	15	$9	5,820
Totals	**23,421**	not applicable	not applicable	**1,630,959**

In addition to annual road maintenance, the Blue Mountains national forests undertake limited annual capital improvement projects. These projects often focus on watershed improvement and include contributions from other Federal, State, Tribal, and private partners. Projects are generally directed at improving aged and deficient road infrastructure (typically culverts and bridges) to allow for improved aquatic organism passage within the National Forest's stream network. Funds used for such improvements are not directed from annual maintenance funding, but rather from specific budget line items dedicated to addressing critical deferred maintenance needs and capital improvement projects.

The allocated annual road maintenance budget for the Blue Mountains national forests only provides approximately 20 percent of the required annual maintenance funds needed to adequately maintain the current open road system. The annual shortfall adds to an already

substantial deferred maintenance backlog. Given the priority of maintaining passenger vehicle roads, much of the deferred maintenance will fall on maintenance level 1 and 2 roads, which represent 93 percent of the road network. Many of these roads are decades old with aging infrastructure that may require partial or targeted reconstruction in order to meet hydrologic standards. The continued maintenance of an extensive road system creates many challenges. Roads in disrepair create safety issues and conflicts with resource protection goals. Wildlife, soil and water quality, and the spread of noxious weeds are negatively affected by the degree and public use of the transportation system. Road closures have only been moderately successful, with many road closures breached. The future road system will reflect how the Forest Service funds and supports road maintenance, reconstruction, and decommissioning efforts.

Road maintenance costs are not equal across the Blue Mountains national forests. A majority of Forest Service units within the broader region (Oregon and Washington) have phased out internal (Forest Service) maintenance capabilities, opting instead to complete maintenance activities through external contracting. While the majority of forests within the region have developed and adopted this structure, the Malheur National Forest has retained internal road maintenance capabilities through Forest Service road maintenance staffing and equipment, resulting in the potential for slightly lower road maintenance costs. The projected annual maintenance objectives vary within each national forest for the plan revision alternatives, reflecting the varying road maintenance structure for each national forest.

Table 9. Current maintenance levels and total miles of Forest Service roads for each national forest (existing condition/1990 forest plans based on 2009 data)

Road Maintenance Level (ML)	Malheur Miles (Percent)	Umatilla Miles (Percent)	Wallowa-Whitman Miles (Percent)
Custodial care (closed roads)	2,856 (30%)	2,447 (53%)	4,398 (49%)
High clearance vehicle roads (ML 2)	6,423 (67%)	1,574 (34%)	4,333 (47%)
Passenger vehicle roads (ML 3)	54 (< 1%)	398 (8%)	262 (3%)
Double lane passenger vehicle roads (MLs 4 and 5)	318 (3%)	232 (5%)	126 (1%)
Totals	**9,651 (100%)**	**4,651 (100%)**	**9,119 (100%)**

Area Suitable for Summer Motor Vehicle Use (Alternative A)

Key Indicator

- National Forest System lands that would be suitable for motor vehicle route designation and use or suitable only for nonmotorized use (acres)
    - ♦ Change in acres suitable for summer motor vehicle route designation and use

During the last 25 years, Forest Service project analyses have determined that many roads could be closed or decommissioned to improve resource conditions. Some benefits of these closures include reducing disturbances to wildlife, improving water quality, and reducing road maintenance costs.

The following table displays the amount of each national forest that is suitable for motor vehicle use in the 1990 forest plans.

Table 10. Area suitable and available for motor vehicle use for each national forest (existing condition/1990 forest plans based on 2009 data)

National Forest	Acres Suitable for Motor Vehicle Use	Percent of National Forest
Malheur	1,428,100 acres	84%
Umatilla	934,200 acres	67%
Wallowa-Whitman	1,315,800 acres	74%

Area Suitable Only for Summer Nonmotorized Use (Alternative A)

Key Indicator

- National Forest System lands that would be suitable for motor vehicle route designation and use or suitable only for nonmotorized use (acres)
  - ♦ Change in acres suitable only for summer nonmotorized use (where motor vehicle use would be prohibited)

The Blue Mountains national forests provide large land areas for primitive, unconfined, and undeveloped outdoor recreation experiences for visitors to experience solitude, remoteness, isolation, or a sense of wildness. These national forests provide uncrowded wilderness and high potential opportunities for experiencing solitude and provide for cultural and spiritual values, areas of historic significance, scenic vistas, and hunting and fishing. Social values related to nonmotorized, unconfined outdoor recreation experiences in wilderness areas or potential wilderness areas include:

- Large blocks of wild, unroaded, unfragmented forests to provide intact habitat, landscapes, canopy cover, natural regeneration, history, and wilderness experience.
- Areas for spiritual uses to enhance solace of open, quiet, beautiful places reserved for such recreation and in respect and honor of other species.
- Areas that provide solitude, high biological value, clean water, wildlife habitat, healthy fisheries, and a boost to rural economic development with tourism.

Even though the Blue Mountains provide high potential opportunities for unconfined recreation experiences and solitude, regionally and locally, the social demand for these unconfined experiences can also be related to general dispersed settings, not just wilderness, that provides both motorized and nonmotorized activities.

Table 11. Area suitable and available for nonmotorized use where motor vehicle use would be prohibited for each national forest (existing condition/1990 forest plans)

National Forest	Acres Suitable only for Nonmotorized Use	Percent of National Forest
Malheur	272,000	16%
Umatilla	460,200	33%
Wallowa-Whitman	438,600	25%

Area Suitable for Winter Over-the-snow Motor Vehicle Use (Alternative A)

Key Indicator

- National Forest System lands that would be suitable for motor vehicle route designation and use or suitable only for nonmotorized use (acres)
    - ♦ Change in area suitable for winter over-the snow motor vehicle use

This indicator reflects the potential level of change in acres suitable for motor vehicle use for each of the plan revision alternatives. Recreation is the most notable use of over-snow vehicles. However, for many people, the use of over-snow vehicles is part of their everyday life and allows them to access their property during the winter months. With adequate snow and when properly operated and managed, over-snow vehicles do not make direct contact with soil, water, and vegetation and generally permanent trails are not created.

Table 12. Area suitable for winter over-the-snow motor vehicle use for each national forest (existing condition/1990 forest plans)

National Forest	Acres Suitable for Winter Motor Vehicle Use	Percent of National Forest
Malheur	1,575,500	92%
Umatilla	1,061,700	76%
Wallowa-Whitman	1,369,200	77%

Road Maintenance (All Plan Revision Alternatives)

Key Indicator

- Road maintenance funds projected to be available to maintain the transportation system
    - ♦ Projected road maintenance for each road maintenance level (miles)

Effects Common to All Plan Revision Alternatives

Access is a function of the area suitable for motor vehicle use, the season, and miles of roads and trails that are maintained and at what level. Access is also a function of what miles of open motor vehicle routes would be available to the public for recreation and driving while still meeting the open motor vehicle route density. The desired condition for open motor vehicle route density varies by alternative and depends on the themes of the alternatives.

The desired conditions, objectives, and budget levels are discussed in detail in Appendix A.

Effects from Alternative B on Road Maintenance

Based on the objectives for this alternative, Table 13 displays the annual miles of road maintenance that are expected to occur during the first decade of the plan period for Alternative B. Road maintenance is directly related to budget, and no change in the road maintenance budget is anticipated for this alternative. As a result, the expected maintenance levels are essentially the same as expected for Alternative A.

It is also assumed that open motor vehicle route density desired conditions would be met by reclassifying some maintenance level 2 roads to maintenance level 1 (custodial care) roads through individual project planning and decision making. These would become maintenance level 1 roads (custodial care), and while no road maintenance is expected for maintenance level 1

roads, standard practice indicates that areas with site-specific resource concerns would be treated as necessary.

The desired conditions, objectives, and budget levels are discussed in detail in Appendix A.

Table 13. Projected annual road maintenance and total miles of National Forest System roads for Alternative B for each national forest

Road Maintenance Level (ML)	MAL Total Road Miles	MAL Miles Projected Annual Maintenance	UMA Total Road Miles	UMA Miles Projected Annual Maintenance	WAW Total Road Miles	WAW Miles Projected Annual Maintenance
Custodial care (closed roads, ML 1)	3,514	0	2,489	0	4,505	0
High clearance vehicle roads (ML 2)	5,765	900	1,532	110	4,225	218
Passenger vehicle roads (ML 3)	54	11	398	159	262	147
Double lane passenger vehicle roads (MLs 4 and 5)	318	225	232	158	126	79
Totals	**9,651**	**1,136**	**4,651**	**427**	**9,118**	**444**

MAL = Malheur, UMA = Umatilla, WAW = Wallowa-Whitman

Effects from Alternative C on Road Maintenance

Based on the objectives for this alternative, Table 14 displays the annual miles of road maintenance that are expected to occur during the first decade of the plan period for Alternative C. The estimated cost to accomplish the project annual maintenance is compared to current funding levels, and the comparison is represented as a percentage. Based on this comparison, it is estimated that accomplishing maintenance objectives for Alternative C would require funding levels to be 80 percent lower for the Malheur National Forest, 50 percent lower for the Umatilla National Forest, and 55 percent lower for the Wallowa-Whitman National Forest. These maintenance objectives would prioritize wildlife habitat and watershed restoration work.

Table 14. Projected annual road maintenance and total miles of Forest Service roads for Alternative C for each national forest

Road Maintenance Level (ML)	MAL Total Road Miles	MAL Miles Projected Annual Maintenance	UMA Total Road Miles	UMA Miles Projected Annual Maintenance	WAW Total Road Miles	WAW Miles Projected Annual Maintenance
Custodial care (closed roads)	4,131	0	2,583	0	4,894	0
High-clearance vehicle roads (ML 2)	5,148	64	1,438	100	3,836	75
Passenger vehicle roads (ML 3)	54	11	398	79	262	79
Double lane passenger vehicle roads (MLs 4 and 5)	318	160	232	30	126	50
Totals	**9,651**	**235**	**4,651**	**209**	**9,118**	**204**

MAL = Malheur, UMA = Umatilla, WAW = Wallowa-Whitman

It is also assumed that open motor vehicle route density desired conditions would be met by reclassifying some maintenance level 2 roads to maintenance level 1 (custodial care) roads through individual project planning and decision making. While no road maintenance is expected for maintenance level 1 roads, standard practice indicates that areas with site-specific resource concerns would be treated as necessary. These reductions in open motor vehicle routes would result in distribution of maintenance over a considerably smaller transportation system.

The desired conditions, objectives, and budget levels are discussed in detail in Appendix A.

Effects from Alternative D on Road Maintenance

Based on the objectives for this alternative, Table 15 displays the annual miles of road maintenance that are expected to occur during the first decade of the plan period for Alternative D. The estimated cost to accomplish the projected annual maintenance is compared to current funding levels and is represented as a percentage. Based on this comparison, it is estimated that accomplishing annual maintenance objectives for Alternative D would require annual funding levels to be 40 percent higher for the Malheur National Forest, 115 percent higher for the Umatilla National Forest, and 60 percent higher for the Wallowa-Whitman National Forest. These maintenance objectives would allow greater public access and ensure that roads necessary to accomplish vegetation treatments are available.

Table 15. Projected annual road maintenance and total miles of Forest Service roads for Alternative D for each national forest

Road Maintenance Level (ML)	MAL Total Road Miles	MAL Miles Projected Annual Maintenance	UMA Total Road Miles	UMA Miles Projected Annual Maintenance	WAW Total Road Miles	WAW Miles Projected Annual Maintenance
Custodial care (closed roads)	2,862	0	2,448	0	4,406	0
High clearance vehicle roads (ML 2)	6,418	1,280	1,573	400	4,325	400
Passenger vehicle roads (ML 3)	54	44	398	300	262	200
Double lane passenger vehicle roads (MLs 4 and 5)	318	280	232	210	126	100
Totals	**9,651**	**1,604**	**4,651**	**910**	**9,118**	**700**

MAL = Malheur, UMA = Umatilla, WAW = Wallowa-Whitman

It is also assumed that open motor vehicle route density desired conditions would be met by reclassifying maintenance level 2 roads to maintenance level 1 (custodial care) roads through individual project planning and decision making. While no road maintenance is expected for maintenance level 1 roads, standard practice indicates that areas with site-specific resource concerns would be treated as necessary.

The desired conditions, objectives, and budget levels are discussed in detail in Appendix A.

Effects from Alternative E, E-Modified, and E-Modified Departure on Road Maintenance

Based on the objectives for this alternative, Table 16 displays the annual miles of road maintenance that are expected to occur during the first decade of the plan period for Alternative

E, E-Modified, and E-Modified Departure. The estimated cost to accomplish the projected annual maintenance is compared to current funding levels and is represented as a percentage. Based on this comparison, it is estimated that accomplishing annual maintenance objectives for Alternative E would require annual funding levels to be 15 percent higher for the Malheur National Forest, 25 percent higher for the Umatilla National Forest, and 20 percent lower for the Wallowa-Whitman National Forest.

These maintenance objectives would provide the Forest Service with the ability to address soils, hydrologic, and wildlife habitat concerns in addition to providing public access and access for vegetation treatments and fuels reductions activities.

It is also assumed that open motor vehicle route density desired conditions would be met by reclassifying maintenance some level 2 roads to maintenance level 1 (custodial care) roads through individual project planning and decision making. While no road maintenance is expected for maintenance level 1 roads, standard practice indicates that areas with site-specific resource concerns would be treated as necessary.

The desired conditions, objectives, and budget levels are discussed in detail in Appendix A.

Table 16. Projected annual road maintenance and total miles of Forest Service roads for Alternatives E, E-Modified, and E-Modified Departure for each national forest

Road Maintenance Level (ML)	MAL Total Road Miles	MAL Miles Projected Annual Maintenance	UMA Total Road Miles	UMA Miles Projected Annual Maintenance	WAW Total Road Miles	WAW Miles Projected Annual Maintenance
Custodial care (closed roads)	3,524	0	2,585	0	4,553	0
High clearance vehicle roads (ML 2)	5,755	1,025	1,505	140	4,177	110
Passenger vehicle roads (ML 3)	54	38	398	200	262	159
Double lane passenger vehicle roads (MLs 4 and 5)	318	250	232	200	126	90
Totals	**9,651**	**1,313**	**4,651**	**540**	**9,118**	**359**

MAL = Malheur, UMA = Umatilla, WAW = Wallowa-Whitman

Effects from Alternative F on Road Maintenance

Based on the objectives for this alternative, Table 17 displays the annual miles of road maintenance that are expected to occur during the first decade of the plan period for Alternative F. The estimated cost to accomplish the projected annual maintenance is compared to current funding levels and is represented as a percentage. Based on this comparison, it is estimated that accomplishing annual maintenance objectives for Alternative F would require annual funding levels to be 15 percent higher for the Malheur National Forest, 25 percent higher for the Umatilla National Forest, and 20 percent lower for the Wallowa-Whitman National Forest.

These maintenance objectives would provide the Forest Service with the ability to address soils, hydrologic, and wildlife habitat concerns.

Table 17. Projected annual road maintenance and total miles of Forest Service roads for Alternative F for each national forest

Road Maintenance Level (ML)	MAL Total Road Miles	MAL Miles Projected Annual Maintenance	UMA Total Road Miles	UMA Miles Projected Annual Maintenance	WAW Total Road Miles	WAW Miles Projected Annual Maintenance
Custodial care (closed roads)	2,984	0	2,516	0	4,496	0
High clearance vehicle roads (ML 2)	6,395	1,000	1,505	125	4,233	100
Passenger vehicle roads (ML 3)	54	32	398	190	262	149
Double lane passenger vehicle roads (MLs 4 and 5)	318	250	232	200	126	90
Totals	**9,651**	**1,313**	**4,651**	**540**	**9,119**	**359**

MAL = Malheur, UMA = Umatilla, WAW = Wallowa-Whitman

It is also assumed that open motor vehicle route density desired conditions would be met by reclassifying maintenance level 2 roads to maintenance 1 (custodial care) roads through individual project planning and decision making. While no road maintenance is expected for maintenance level 1 roads, standard practice indicates that areas with site-specific resource concerns would be treated as necessary.

The desired conditions, objectives, and budget levels are discussed in detail in Appendix A.

Area Suitable for Summer Motor Vehicle Use and Areas Suitable Only for Summer Nonmotorized Use (Alternatives B, C, D, E, E-Modified, E-Modified Departure, and F)

Key Indicator

- National Forest System lands that would be suitable for motor vehicle route designation and use or suitable only for nonmotorized use (acres)
  - Change in acres suitable for summer motor vehicle route designation and use
  - Change in acres suitable only for summer nonmotorized use (where motor vehicle use would be prohibited)

Effects Common to All Plan Revision Alternatives

Access is also represented by trail routes that are accessed by either motor vehicle means, such as off-highway vehicles or motorcycles, or by nonmotorized means, such as horses, bikes, or foot travel. The alternatives vary the amount of acres that are rated as generally suitable for motor vehicle use for both summer and winter. The desired conditions, objectives, and budget levels are discussed in detail in Appendix A, Volume 4.

For some alternatives, management direction for areas that currently are unsuitable for motor vehicle use may change to suitable for motor vehicle use. Nonmotorized trails in these areas would continue to be nonmotorized unless a subsequent site-specific decision is made to change the type of use. Users of those trails can expect the same experience they currently have. Future project planning and decision making may allow for increased motor vehicle access in those

areas, resulting in potential impacts to nonmotorized users (e.g., seeing and hearing motor vehicles).

The following tables display the acres suitable for summer motor vehicle use for each national forest in each alternative.

Table 18. Acres suitable for summer use of motor vehicle routes by alternative for each national forest

National Forest	Alternative A	Alternative B	Alternative C	Alternative D	Alternatives E and F	Alternatives E-Modified and E-Modified Departure
Malheur	1,428,000	1,555,400	897,100	1,613,800	1,535,800	1,539,900
Umatilla	934,200	1,053,200	556,700	1,068,700	975,200	986,700
Wallowa-Whitman	1,315,800	1,311,200	620,100	1,327,300	1,204,800	1,282,900

Effects from Alternative B on Areas Suitable for Motor Vehicle Use and Areas Suitable Only for Nonmotorized Use

For this alternative, management areas would be allocated differently than in the 1990 forest plans. See the description of the alternatives in Chapter 2. Due to the change in management area allocations, there would be a change in the number of acres suitable for motor vehicle use, both in summer and in winter.

Table 19. Change in acres suitable for summer motor vehicle use and summer nonmotorized use* for Alternative B for each national forest

National Forest	Acres Suitable for Summer Motor Vehicle Routes (% of national forest)	Percent Change in Acres Suitable for Motor Vehicle Summer Routes (from existing condition)	Percent Change in Acres Suitable Only for Nonmotorized Summer Use* (from existing condition)
Malheur	1,555,400 (91%)	9% increase	46% decrease
Umatilla	1,053,200 (75%)	13% increase	24% decrease
Wallowa-Whitman	1,311,200 (74%)	0% change	5% decrease

* Nonmotorized use areas where motor vehicle use would be prohibited.

Within the Malheur National Forest, there would be an increase in acres suitable for summer motor vehicle use and a decrease in acres suitable only for summer nonmotorized use compared to Alternative A. This is due to most of MA 4C (Old Forest) in the 1990 Forest Plan being suitable only for nonmotorized use. MA 4C generally consists of small areas intermixed with MA 4A General Forest/Timber/Range. In this alternative, those small areas would be reallocated to MA 4A. See the section on “Old Forest” for more information. The effect of changing this allocation from suitable only for nonmotorized use to suitable for motor vehicle use would be minimal.

Within the Umatilla National Forest, there would be an increase in area suitable for motor vehicle use in the summer due to the same reallocation of MA 4C to MA 4A discussed for the Malheur National Forest. The amount of area allocated to MA 3B Backcountry (motorized use) would increase in this alternative compared to Alternative A.

Within the Wallowa-Whitman National Forest, there would be a very slight increase in area suitable for summer motor vehicle use. The 2 percent decrease in area suitable only for summer nonmotorized use would be due to the reallocation of MA 4C to MA 4A.

Effects from Alternative C on Areas Suitable for Motor Vehicle Route Designation and Use and Areas Suitable Only for Nonmotorized Use

For this alternative, management area allocations would be different from those presented in the 1990 forest plans. The alternatives are described in Chapter 2, and the tables displaying acres by management area are in Appendix A, Volume 4. The change in management area allocations would result in a change in acres suitable for motor vehicle use, both in summer and in winter (Table 20).

This alternative emphasizes increased suitability for nonmotorized uses and low open motor vehicle route density in areas suitable for motor vehicle use. Alternative C presents the largest increase in acres allocated to MA 3A Backcountry (nonmotorized use), from 76,000 acres in the existing condition to 630,000 acres for all three National Forests. This eight-fold increase would affect motor vehicle routes and trails in areas that were previously suitable for motor vehicle use. Over time, this would reduce the trails and roads suitable for motor vehicle use. This alternative would not allocate any area to MA 3B Backcountry (motorized use). Similarly, Alternative C allocates more acres to MA 3C Wildlife Corridors compared to Alternatives E and F. Alternatives B, D, E-Modified, and E-Modified Departure do not assign any acreage to this management area. MA 3C areas are designed to provide wildlife corridors to connect habitat, and the desired condition for open route density in this management area would be 1 mile per square mile.

Table 20. Change in acres suitable for summer motor vehicle use and summer nonmotorized use* for Alternative C for each national forest

National Forest	Acres Suitable for Summer Motor Vehicle Routes (% of national forest)	Percent Change in Acres Suitable for Motor Vehicle Summer Routes (from existing condition)	Percent Change in Acres Suitable for Nonmotorized Summer Use* (from existing condition)
Malheur	897,100 (52%)	37% decrease	200% increase
Umatilla	556,700 (40%)	40% decrease	89% increase
Wallowa-Whitman	620,100 (35%)	53% decrease	156% increase

* Nonmotorized use areas where motor vehicle use would be prohibited.

Effects from Alternative D on Areas Suitable for Motor Vehicle Route Designation and Use and Area Suitable Only for Nonmotorized Use

Alternative D (Table 21) emphasizes maintaining or expanding the current amount of acres suitable for motor vehicle. This alternative would not allocate any National Forest System lands to MA 1B Preliminary Administratively Recommended Wilderness Areas or MA 3A Backcountry (nonmotorized use).

Table 21. Change in acres suitable for summer motor vehicle use and summer nonmotorized use* for Alternative D for each national forest

National Forest	Acres Suitable for Summer Motor Vehicle Routes (% of national forest)	Percent Change in Acres Suitable for Motor Vehicle Summer Routes (from existing condition)	Percent Change in Acres Suitable for Nonmotorized Summer Use* (from existing condition)
Malheur	1,613,800 (94%)	13% increase	68% decrease
Umatilla	1,068,700 (76%)	14% increase	28% decrease
Wallowa-Whitman	1,327,300 (75%)	1% increase	8% decrease

* Nonmotorized use areas where motor vehicle use would be prohibited.

Effects from Alternatives E and F on Areas Suitable for Motor Vehicle Route Designation and Use and Areas Suitable Only for Nonmotorized Use

Approximately 91,000 acres would be allocated to MA 1B Preliminary Administratively Recommended Wilderness Areas. This would contribute to the change in acres suitable for motor vehicle use displayed in Table 20 and Table 21. Alternatives E and F allocate less acres to MA 3C Wildlife Corridors compared to Alternative C (Table 22). Alternatives B, D, E-Modified, and E-Modified Departure do not assign any acreage to this management area. MA 3C areas are designed to provide wildlife corridors to connect habitat, and the desired condition for open route density in this management area would be 1 mile per square mile.

Table 22. Change in acres suitable for summer motor vehicle use and summer nonmotorized use* for Alternatives E and F for each national forest

National Forest	Acres Suitable for Summer Motor Vehicle Routes (% of national forest)	Percent Change in Acres Suitable for Motor Vehicle Summer Routes (from existing condition)	Percent Change in Acres Suitable for Nonmotorized Summer Use* (from existing condition)
Malheur	1,535,800 (90%)	8% increase	37% decrease
Umatilla	975,200 (69%)	4% increase	4% decrease
Wallowa-Whitman	1,204,800 (68%)	8% decrease	21% increase

* Nonmotorized use areas where motor vehicle use would be prohibited.

For Alternatives E and F, MAs 1A, 2B, 2I, and 3A would be unsuitable for motor vehicles.

Effects from Alternatives E-Modified and E-Modified Departure on Areas Suitable for Motor Vehicle Route Designation and Use and Areas Suitable Only for Nonmotorized Use

Approximately 70,500 acres would be allocated to MA 1B Preliminary Administratively Recommended Wilderness Areas. This would contribute to the change in acres suitable for motor vehicle use displayed in Table 20 and Table 21. Alternatives E-Modified and E-Modified Departure do not allocate acres to MA 3C Wildlife Corridors and is less compared to Alternatives C, E, and F (Table 23). Alternatives B, and D do not assign any acreage to this management area. MA 3C areas are designed to provide wildlife corridors to connect habitat, and the desired condition for open route density in this management area would be 1 mile per square mile.

Table 23. Change in acres suitable for summer motor vehicle use and summer nonmotorized use* for Alternatives E-Modified and E-Modified Departure for each national forest

National Forest	Acres Suitable for Summer Motor Vehicle Routes (% of national forest)	Percent Change in Acres Suitable for Motor Vehicle Summer Routes (from existing condition)	Percent Change in Acres Suitable for Nonmotorized Summer Use* (from existing condition)
Malheur	1,539,900 (90%)	8% increase	41% decrease
Umatilla	986,700 (70%)	6% increase	11% decrease
Wallowa-Whitman	1,282,900 (72%)	2% decrease	3% increase

* Nonmotorized use areas where motor vehicle use would be prohibited.

For Alternatives E-Modified and E-Modified Departure, MAs 1A, 1B, 2B, 2I, and 3A would be unsuitable for motor vehicles.

Area Suitable for Winter Over-the-snow Motor Vehicle Use (Alternatives B, C, D, E, E-Modified, E-Modified Departure, and F)

Key Indicator

- National Forest System lands that would be suitable for motor vehicle route designation and use or suitable only for nonmotorized use (acres)
  - ♦ Change in area suitable for winter over-the-snow motor vehicle use

Effects Common to Alternatives B, C, D, E, E-Modified, E-Modified Departure, and F

There would be no desired conditions, standards, or guidelines for over-the-snow travel. Management direction for over-the-snow travel is provided by Code of Federal Regulations and site specific project decisions.

The following tables display the acres suitable for winter motor vehicle use for each national forest in each alternative.

Table 24. Acres suitable for winter motor vehicle use by alternative for each national forest

National Forest	Alternative A	Alternative B	Alternative C	Alternative D	Alternatives E and F	Alternatives E-Modified and E-Modified Departure
Malheur	1,575,500	1,556,600	1,067,000	1,616,000	1,568,400	1,542,100
Umatilla	1,061,700	1,054,600	652,300	1,072,400	1,019,000	994,200
Wallowa-Whitman	1,369,200	1,322,000	870,400	1,335,000	1,232,800	1,290,600

Effects from Alternative B on Areas Suitable for Over-the-snow Motor Vehicle Use

All three National Forests would have very slight changes in acres suitable for winter motor vehicle use in this alternative. MA 3A would be slightly larger for this alternative in some locations, which is rated unsuitable for winter motor vehicle use. The percent of the national forests available for winter motor vehicle use would change only minimally from the existing condition. The changes are due to minor adjustments in management area allocations.

Table 25. Acres suitable for over-the-snow motor vehicle use in MAs 1B, 3B, 4A, 4B, and 5 under Alternative B for each national forest

National Forest	Acres Suitable for Winter Motor Vehicle Use (% of national forest)	Percent Change from Existing Condition
Malheur	1,556,600 (91%)	1% decrease
Umatilla	1,054,600 (75%)	1% decrease
Wallowa-Whitman	1,322,000 (75%)	3% decrease

Effects from Alternative C on Areas Suitable for Over-the-snow Motor Vehicle Use

All three National Forests would have large changes in acres suitable for winter motor vehicle use in this alternative. All of the acres allocated to back country management area designation would be allocated to MA 3A which is rated as unsuitable for winter motor vehicle use. Winter motor vehicle use would be suitable in MAs 4A and 5. In addition, MA 1B would be rated unsuitable for winter motor vehicle use in this alternative, as show in the general suitability matrix in Appendix A, Volume 4. This alternative would have the greatest change in the availability of snow play areas of all alternatives, in addition to potential effect to the groomed snowmobile routes that travel through MA 3C, as additional route restrictions may occur to meet route density standards in the summer. Future project level planning and decisionmaking would be conducted to determine the appropriate time of year for motor vehicle use for individual routes.

Table 26. Acres suitable for over-the-snow motor vehicle use in MAs 4A, 4B, 4C, and 5 under Alternative C for each national forest

National Forest	Acres Suitable for Winter Motor Vehicle Use (% of national forest)	Percent Change from Existing Condition
Malheur	1,067,000 (62%)	32% decrease
Umatilla	652,300 (46%)	39% decrease
Wallowa-Whitman	870,400 (49%)	36% decrease

Management areas that contribute to a reduction in acres suitable for motor vehicle use would also be unsuitable for winter motor vehicle use on both routes and trails and for cross-country travel. MAs 1A, 1B, 1C, 2B, 2I, and 3A would not be suitable for winter motor vehicle use. MA 3C would be suitable for over-the-snow motor vehicle use only on groomed trails (cross-country travel would be prohibited). The groomed winter trail system in MA 3C would not be allowed to exceed the summer open motor vehicle route density, which would be 1 mile per square mile.

Effects from Alternative D on Areas Suitable for Over-the-snow Motor Vehicle Use

For Alternative D, only slight changes in acres suitable for winter motor vehicle use would occur, which would include increases in the total acres for the Umatilla and Malheur National Forests. There would be no allocations to MA 3A, resulting in an overall increase in area rated suitable for winter motor vehicle use. In addition, there would be no allocations to MA 1B. Winter motor vehicle use would be suitable in MAs 3B, 4A, 4B, and 5.

For Alternative D, only MAs 1A, 2B, and 2I would not be suitable for winter motor vehicle use. The intent of this alternative is to minimize effects to motor vehicle use. Therefore, only the management areas where motor vehicle use would be prohibited by law or by research would be unsuitable for winter motor vehicle use

Table 27. Acres suitable for over-the-snow motor vehicle use in MAs3B, 4A, 4B, and 5 under Alternative D for each national forest

National Forest	Acres Suitable for Winter Motor Vehicle Use (% of national forest)	Percent Change from Existing Condition
Malheur	1,616,000 (95%)	3% increase
Umatilla	1,072,400 (76%)	1% increase
Wallowa-Whitman	1,335,000 (75%)	2% decrease

Effects from Alternatives E and F on Areas Suitable for Over-the-snow Motor Vehicle Use

All three National Forests would have slight changes in acres suitable for winter motor vehicle use in this alternative. MA 3A would be allocated in this alternative in some locations, which is rated unsuitable for winter motor vehicle use. Winter motor vehicle use would be suitable in MAs 1B, 3B, 4A, 4B, and 5, much like Alternative B. Over-the-snow motor vehicle would still be allowed in MA 1B, as displayed in the suitability table in Appendix A, Volume 4.

Table 28. Change in acres suitable for winter motor vehicle use in MAs 1B, 3B, 4A, 4B, and 5 under Alternatives E and F for each national forest

National Forest	Acres Suitable for Winter Motor Vehicle Use (% of national forest)	Percent Change from Existing Condition
Malheur	1,568,400 (92%)	0% decrease
Umatilla	1,019,000 (73%)	4% decrease
Wallowa-Whitman	1,232,800 (70%)	10% decrease

Effects from Alternatives E-Modified and E-Modified Departure on Areas Suitable for Over-the-snow Motor Vehicle Use

All three National Forests would have slight changes in acres suitable for winter motor vehicle use in this alternative. MA 3A would be allocated in this alternative in some locations, which is rated unsuitable for winter motor vehicle use. Winter motor vehicle use would be suitable in MAs 3B, 4A, 4B, and 5. MA 1B would be rated unsuitable for over-the-snow motor vehicle use in this alternative, as show in the general suitability matrix in Appendix A.

Table 29. Change in acres suitable for winter motor vehicle use by national forest for Alternatives E-Modified and E-Modified Departure for each national forest

National Forest	Acres Suitable for Winter Motor Vehicle Use (% of national forest)	Percent Change from Existing Condition
Malheur	1,542,100 (90%)	2% decrease
Umatilla	994,200 (71%)	6% decrease
Wallowa-Whitman	1,290,600 (73%)	6% decrease

Access – Cumulative Effects

Implementation of all alternatives would affect access over time. The Revised Forest Plans provide suitability ratings for motor vehicle use (both summer and winter) and for road and trail construction for each management area. Management area acres vary by alternative: some

alternatives result in an increase in acres (compared to Alternative A) that are rated suitable for motor vehicle use, while other alternatives result in less acres. Although the amount of area available for motor vehicle use varies by alternative, road-related standards, guidelines, and desired conditions for resource areas including watershed and wildlife may require reductions of the existing transportation system to meet those resource area desired conditions, standards, and guidelines. Adjustments to the national forest transportation system to meet proposed management direction in the forest plan would require site-specific, project-level decisions.

Minimal new road construction would occur for all alternatives. Road reconstruction would emphasize user safety and prevention or correction of resource impacts. If maintenance funding decreases, roads determined to be unsafe and of low priority for maintenance would likely have to be closed. Current trail maintenance levels would continue.

The cumulative effects analysis area for access is defined by the county boundaries for the counties within the Plan Area, which are Baker, Grant, Harney, Morrow, Umatilla, Union, Wallowa, and Wheeler counties in Oregon and Asotin, Columbia, and Garfield counties in Washington. This cumulative effects area is used because local communities and visitors to the area are generally looking for a type of motor vehicle or nonmotorized use that can occur on public or private lands, but normally would not occur outside of the county boundary.

Within the cumulative effects area, National Forest System lands, Bureau of Land Management lands, state lands, industrial timber lands, and other private lands are available for public access. The trend on these lands has been for more restrictions on motor vehicle uses.

The Baker Field Office for the Bureau of Land Management released a Draft Resource Management Plan (USDI 2011) that describes the existing condition to be an array of roads that are currently open, and much of the surrounding lands are open for cross-country motor vehicle travel. The Bureau of Land Management’s draft plan states that a travel management plan to designate open routes would be completed within five years of signing the record of decision for their Final Resource Management Plan. However, the Bureau of Land Management’s draft plan does propose interim direction to designate areas as open to cross country motor vehicle travel, limited to existing routes and trails, or closed to cross country motor vehicle travel. The Bureau of Land Management’s environmental impact statement describes their Alternative E as designating only one existing off-highway vehicle area as open to cross country motorized travel, identifies several areas closed to cross-country motor vehicle travel, and designates the remaining areas as limited to existing roads and trails. Analyses of the management situation for other BLM lands within the analysis area associated with the southeast Oregon area and the John Day River Basin have identified a need to address unrestricted motor vehicle use. Completion of resource management plans and travel management plans for these areas will likely lead to future reductions of motor vehicle use opportunities.

On State, industrial timber lands, and other private lands, the trend for motor vehicle use is not evident because it is specific to the managing state agency, timber land owner, or private owner.

The Hells Canyon National Recreation Area, under the administration of the Wallowa-Whitman National Forest, contains outstanding recreational and ecologic values and provides public enjoyment opportunities resulting from the ecosystem functions present within the National Recreation Area. The Hells Canyon National Recreation Area Comprehensive Management Plan, as amended to the Wallowa-Whitman National Forest 1990 forest plan, includes added protections for these resources as outlined in Section 7 of the Hells Canyon National Recreation Act (P.L. 94-199).

Access-related management is described in the Hells Canyon National Recreation Area Comprehensive Management Plan and provides the following management direction:

- Limits use of motorized and mechanical equipment to designated open roads and trails except where authorized by permit.
- Manages road densities to prescribed levels.
- Maintains the Hells Canyon Scenic Byway.
- Provides direction for trail construction and reconstruction.
- Retains backcountry airstrips, and specifies continued allowable uses.
- Establishes over-snow vehicle travel routes and play areas and allowable use conditions.

Access-related management direction for the Hells Canyon National Recreation Area more closely conforms to management direction outlined in the regulations at 36 CFR 212, the implementing regulation for the Forest Service’s Travel Management Rule (2005).

The cumulative effect of reduced motor vehicle access on Bureau of Land Management lands, combined with the plan revision alternatives proposed in this analysis and the existing management direction for the Hells Canyon National Recreation Area may intensify the adverse effect experienced by those who desire more motor vehicle access and increase the beneficial effect experienced by those who desire less motor vehicle access. The opportunity to displace motor vehicle access from the national forests to other jurisdictions or ownerships would not be available under expected trends.

Issue 2: Economic and Social Well-being

Changes Made Between the Draft and Final Environmental Impact Statements

Aside from the global changes throughout this environmental impact statement described in the Preface to this document, the following changes were made specifically to this section:

- The affected environment data on social and economic conditions has been updated to 2014.
- IMPLAN (input-output model) was re-created using 2014 data.
- We added a values, attitudes, and beliefs study to better address social aspects of the plan revision.
- We incorporated public comments throughout the social and economic analysis to make connections between the data and stakeholders’ lived experiences and perceptions.
- We added substantially to the community resilience analysis to better capture the challenges faced by communities in the three socio-economic impact zones.
- We revised the environmental justice analysis in both the “Affected Environment” and “Environmental Consequences” sections.
- We added social and economic effects analysis for additional alternatives (E-Modified and E-Modified Departure).
- We added discussion of natural resource-related boom and bust cycles to the environmental consequences section.

- We completely rewrote the cumulative effects analysis.
- We updated best available scientific information where appropriate.

Introduction and Purpose

Forest plan decisions create the framework for the range of uses, products and services provided by the Blue Mountains national forests that contribute to the economic and social well-being of local counties, communities, Tribes, and families. Forest products and services support the maintenance of local business infrastructure. The infrastructure, in turn, plays a critical role supporting and enhancing the Forest Service's capacity to conduct management activities.

Forest products, forage for livestock, outdoor recreation opportunities, wildlife habitat, and healthy ecosystems benefit people in communities near the Blue Mountains national forests as well as stakeholders across the region and nation. Many stakeholders in the Blue Mountains region believe that better support of logging and milling infrastructure helps retain the capacity needed to restore national forest lands. Some think, for example, that Forest Service should provide incentives to foster development of new forest-related industry and should support more mill competition. Other stakeholders think that the primary decision making criteria for selecting the chosen alternative for the Blue Mountains Forest Plan Revision should be the economic effects of forest plan revision on local residents and communities. Another frequently expressed belief in the Blue Mountains region is that road closures and limiting motorized use would have negative impacts on local economies and communities' ability to attract new industry. They believe that motorized recreation has a significant positive impact on local economies. This section evaluates the relationship between human well-being and the variety of goods and services provided by the Blue Mountains national forests.

The Forest Plan and the Final Environmental Impact Statement are written with the understanding that people are the stewards, producers, distributors, and users of national forest lands and resources. Forest Service managers depend on their relationships with residents of local communities and institutions, as well as other citizens and partners, to help manage the national forests by providing a skilled workforce, manufacturing infrastructure, business support, and other services cost effectively. People and relationships are important to sustaining and restoring the ecological integrity of the national forests as well as the social and economic conditions of the communities (Cerveny et al. 2017). Figure 3 displays the interconnected relationship between Forest Service management and community capacity.

Figure 3. Relationship between Forest Service and community capacity

Changes in national forest management can affect traditions, lifestyles, and the economic livelihood of residents and communities. Those who depend on the national forests for their livelihoods and recreational pursuits are concerned that their relationship with the national forests may be compromised by other uses and restrictions. For example, designated wilderness areas may limit opportunities for commercial uses (e.g., timber harvesting) on the national forests.

Factors that appear to help make communities resilient to economic and social change include population size and rates of change; economic, social, and cultural diversity; amenity settings; and quality of life. Communities with larger populations tend to have a broader array of industries and a higher number of businesses that function in each industry. More diversified economies do not depend heavily on any single industry or firm. When industries decline and jobs are lost, communities with greater economic diversity are better able to absorb the losses. Forest Service land use decisions often have few economic impacts on communities with large populations and diverse economies.

In contrast, communities with small populations usually have fewer industries and fewer businesses within those industries. A decline in one industry or loss of a business, especially a major employer, can result in job losses that affect many aspects of community life. Job losses can be especially disruptive if the community is geographically isolated with few alternative employment opportunities.

The three Blue Mountains national forests, though similar ecologically, differ in community resiliency, and the communities may be affected differently by changes in national forest management. This section provides existing condition and trend data for the key indicators related to the social and economic environment. The data provide a backdrop to facilitate evaluating and understanding how the alternatives address social and economic issues. These issues may be affected by management actions that would be guided by the forest plan alternatives. The issues also influence the design of the alternatives.

Methods

Social and Economic Impact Zones

Three areas, or socio-economic impact zones, are used to characterize each national forest's economic and social conditions. Counties are combined into the national forest-specific socio-economic zones displayed in Table 30.

Table 30. Socio-economic impact zones

Area	Counties
Malheur Socio-Economic Impact Zone	Grant County, OR Harney County, OR
Umatilla Socio-Economic Impact Zone	Grant County, OR Morrow County, OR Umatilla County, OR Union County, OR Wallowa County, OR Wheeler County, OR Asotin County, WA Columbia County, WA Garfield County, WA Walla Walla County, WA Nez Perce County, ID
Wallowa-Whitman Socio-Economic Impact Zone	Baker County, OR Union County, OR Wallowa County, OR

These socio-economic impact zones were primarily developed considering three criteria: (1) the number of Forest Service-administered acres in each county, which relates to county payments; (2) trade flows of national forest products and by-products moving to and between local processing facilities; (3) interconnected county economies.

A series of human ecology based social studies conducted within the last several years, and public involvement-related mapping exercises completed in conjunction with this plan revision process were also considered in defining socio-economic impact zones. The resulting data suggest that community members tend to conduct business, recreate, and socialize within larger geographic regions called human resource units (James Kent Associates 2006). Human resource unit boundaries generated by this work were similar to the county based socio-economic impact zones in Table 30.

Data and Methodology

The sources for most of the social and demographic data are based on surveys conducted by the U.S. Census Bureau, Bureau of Labor, and Bureau of Economic Analysis. These data are reported at the county level. The advantage of using these data sources at the county scale is the data are readily available and consistent across different geographies. This analysis displays the data by county and by socio-economic impact zone along with state level data as a reference. Counties are large and using data at this level often masks social and economic conditions and trends occurring at the sub-county or community scale. The potential sub-county changes are not quantifiable given the scale of forest plan decisions.

Industry level employment and income data are derived using IMPLAN model data and software (IMPLAN 2014). The IMPLAN data and analysis system provides a level of specificity for employment and income at a finer industry scale than data reported by the Bureau of Economic Analysis. The IMPLAN data and analysis system is also used to estimate the potential contributions of alternative management strategies on the economies of the socio-economic impact zones.

Each national forest and its goods, services, and uses are assigned to the socio-economic impact zone bearing its name. This means the potential social and economic effects related to the management activities on the Malheur National Forest are not identified for businesses that do not exist in the Malheur socio-economic impact zone, even though those businesses may exist in the other two socio-economic impact zones.

Additional methods include a values, attitudes, and beliefs study. The information for this study comes from public comments submitted during the forest plan revision process. The values, attitudes, and beliefs study is one part of the qualitative social analysis. Quantitative data on community well-being complement this qualitative study. Both the quantitative and qualitative data contribute to the evaluation of the alternatives in terms of issues, community social and economic well-being, and other potential effects on communities.

Additional information about data sources and methods is provided as the data are presented.

Economic and Social Well-being – Affected Environment

This section describes social and economic conditions and trends in the areas that may be affected by the plan revision for the Malheur, Umatilla, and Wallowa-Whitman National Forests. The following discussion identifies the economic and social systems in place within the communities

surrounding the Blue Mountains national forests and the people who use and value the natural resources and opportunities the national forests provide.

Demographic and Economic Characteristics

Population Change and Structure

Population characteristics, such as size, composition, and density, along with population dynamics showing how the structure changes over time, are useful to understand the relationship between communities and national forests. Population characteristics can influence how Forest Service management actions affect the human environment.

Population and demographic information can be an indicator of needs for access, outreach, concentration of land use, etc. Population data also helps explain the community's social and economic situation. As illustrated in Table 31, county populations vary greatly. Umatilla County, which is just south of metropolitan counties in Washington, is the most populous with a population of over 76,000. The least populated county in the study region is Wheeler County, OR, with less than 2,000 people. Six out of 13 counties had populations less than 10,000 people (U.S. Census Bureau 2014).

Population change may lead to conflicts over the types of national forest uses, travel management, recreation activities, and opinions about the appropriateness of resource management activities. Most counties saw population decline between 2000 and 2014. Out-migration is not uncommon in rural communities and can signal lack of economic opportunities, but in other places it may be related to geographic isolation and lack of desirable amenities (McGranahan et al. 2010). However, many counties in the socio-economic impact zones have an above average portion of residents 59 years and older, suggesting an imbalance of deaths over births may exist (Table 31). For the three states (Idaho, Oregon, and Washington) in the analysis area and the United States, the percent of the population under 20 years is greater than the population over 59. Nine out of the 13 counties in the socio-economic impact zones have greater percent of the population over 59 than under 20. Three counties (Grant County, OR, and Columbia and Asotin County, WA) are classified as retirement destinations according to the USDA's County Typology Codes (USDA-ERS, 2015). These are counties where the number of residents age 60 and older grew by 15 percent or more due to net migration (USDA-ERS, 2015). These findings indicate that the population is aging and differs from average population growth trends in the U.S. Aging populations may influence national forest management, especially related to travel and access. The effect of retirement-aged people on communities can be complex, but can include bringing in additional sources of income, and opinions about and the desire for different types of recreational activities and access needs. For example, some stakeholders expressed concern about potential limits on forest access because they think it could disproportionately affect children, aging populations, wounded veterans, and people with disabilities. Stakeholder comments included: "The BMFPR fails to address the needs of local elderly and/or disabled individuals in regards to having free and open access to public domain."

Population trends show how the overall numbers of residents have varied in the past and indicate what the population level may be in the future. Population growth can result in increased demands on existing uses and services, such as for access and recreation opportunities. When the population increase is primarily though in-migration, it can result in desires for a different mix of management activities and uses resulting in potential incompatibilities between people with differing values. An increase in users can result in conflicts where crowding occurs, even among people with similar values.

Table 31. Basic population and demographic indicators

Area	Total Population	Percent of Population Under 20 Years	Percent of Population Over 59 Years
Malheur Socio-Economic Impact Zone			
Grant County, OR	7,325	20.4	35.2
Harney County, OR	7,253	23.4	27.7
Umatilla Socio-Economic Impact Zone	**Total Population**	**Percent of Population Under 20 Years**	**Percent of Population Over 59 Years**
Grant County, OR	7,325	20.4	35.2
Morrow County, OR	11,217	30.6	19.1
Umatilla County, OR	76,645	28.9	19.1
Union County, OR	25,736	25.6	24.2
Wallowa County, OR	6,893	20.5	36.0
Wheeler County, OR	1,357	17.1	39.6
Asotin County, WA	21,955	23.3	27.8
Columbia County, WA	4,031	22.6	32.4
Garfield County, WA	2,240	24.4	34.8
Walla Walla County, WA	59,476	26.5	21.3
Nez Perce County, ID	39,655	24.0	24.9
Wallowa-Whitman Socio-Economic Impact Zone	**Total Population**	**Percent of Population Under 20 Years**	**Percent of Population Over 59 Years**
Baker County, OR	16,049	21.6	31.8
Union County, OR	25,736	25.6	24.2
Wallowa County, WA	6,893	20.5	36.0
Oregon	3,900,343	24.6	21.6
Idaho	1,599,464	29.5	19.2
Washington	6,899,123	25.6	19.2
United States	314,107,084	26.3	19.5

Source: U.S. Department of Commerce, Census Bureau, 2010-2014 American Community Survey 5-Year Estimates (Table DP05)

The population size, growth, and density in each of the socio-economic impact zones for the three National Forests are markedly different. With a density of about one person per square mile (U.S. Census Bureau 2000), the population within the Malheur socio-economic impact zone is small compared to the other socio-economic impact zones. The Oregon statewide density was 15 people per square mile (Census 2000). In addition, the population in Grant and Harney counties has declined approximately 6 percent since 2000, as shown in Table 32 (U.S. Census Bureau 2000 and U.S. Census Bureau 2014).

In the Umatilla socio-economic impact zone, the population overall has increased by 14,147, or about six percent (see Table 33). The change at the county level is more complex. Five counties within the socio-economic impact zone, Grant, Wallowa, Wheeler, Columbia, and Garfield, have seen their populations decline since 2000. Most of the population gain since 2000 was in Umatilla County in Oregon and Walla Walla County in Washington. Although the Umatilla socio-economic impact zone grew the most, the overall growth was much less than the Oregon statewide growth over the same time period (16 percent). The Umatilla socio-economic impact zone is the most

densely populated with about 11 people per square mile, four less than the Oregon statewide average. Nez Perce and Walla Walla counties have the highest population densities in the socio-economic impact zone with about 44 people per square mile, and Wheeler County has the lowest density with less than one person per square mile.

The Wallowa-Whitman socio-economic impact zone's population has been steady since 2000 (see Table 34). Both Baker and Wallowa counties decreased by four and five percent respectively, and Union County increased by five percent (Census 2014). The population density of this socio-economic impact zone is six people per square mile (Census 2010).

Table 32. Population change 2000-2014, by county, Malheur Socio-Economic Impact Zone

County	Change in Population
Grant County, OR	-610 (-7.7%)
Harney County, OR	-356 (-4.7%)
Total Change	-966 (-6.2%)

Source: U.S. Census Bureau, 2000 Decennial Census and 2010-2014 American Community Survey 5-Year Estimates (Table DP05)

Table 33. Population Change 2000-2014, by County, Umatilla Socio-Economic Impact Zone

County	Change in Population
Grant County, OR	-610 (-7.7%)
Morrow County, OR	222 (2.0%)
Umatilla County, OR	6,097 (8.6%)
Union County, OR	1,206 (4.9%)
Wallowa County, OR	-333 (-4.6%)
Wheeler County, OR	-190 (-12.3%)
Asotin County, WA	1,404 (6.8%)
Columbia County, WA	-33 (-0.8%)
Garfield County, WA	-157 (-6.5%)
Walla Walla County, WA	4,296 (7.8%)
Nez Perce County, ID	2,245 (6.0%)
Total Change	14,147 (5.9%)

Source: U.S. Census Bureau, 2000 Decennial Census and 2010-2014 American Community Survey 5-Year Estimates (Table DP05)

Table 34. Population change 2000-2014, by county, Wallowa-Whitman Socio-Economic Impact Zone

County	Change in Population
Baker County, OR	-692 (-4.1%)
Union County, OR	1,206 (4.9%)
Wallowa County, OR	-333 (-4.6%)
Total Change	181 (0.4%)

Source: U.S. Census Bureau, 2000 Decennial Census and 2010-2014 American Community Survey 5-Year Estimates (Table DP05)

The population density data for all three socio-economic impact zones are lower than the density for Oregon. Low population density reflects the rural nature of the area, especially of the Malheur and Wallowa-Whitman socio-economic impact zones, compared to the Oregon state average. Residents living in all socio-economic impact zones value the open space, personal independence, rural lifestyle, and the minimal crowding offered by a low population density (see “Values, Attitudes, Beliefs” section). With the low population growth exhibited during the last decade, these conditions are likely to persist.

Urban-Rural Distribution

Wide disparities between urban and rural areas remain in terms of economic conditions, access to infrastructure and services, opportunities for socioeconomic mobility, and control over natural resources. Disparities are caused by natural differences, political decisions, and social factors. While the population density data presented above help to describe the degree of urbanization within the counties, the Economic Research Service has developed urban-rural classification codes that take into account the proximity of the county to metropolitan areas. These codes, ranging from one (most urban) to nine (most rural), capture the extent of geographic isolation in the counties in the socio-economic impact zones.

Table 35 shows that the Malheur socio-economic impact zone is quite rural, with Grant County (OR) categorized as completely rural (USDA-ERS 2013). These data indicate that residents of the Malheur socio-economic impact zone are likely to experience a high degree of geographic isolation.

Table 35. Urban-rural classification, Malheur Socio-Economic Impact Zone

County	Code	Description
Grant, OR	9	Nonmetro - Completely rural or less than 2,500 urban population, not adjacent to a metro area
Harney, OR	7	Nonmetro - Urban population of 2,500 to 19,999, not adjacent to a metro area

Source: U.S. Department of Agriculture, Economic Research Service 2013

Table 36 shows the urban-rural classifications for counties in the Umatilla socio-economic impact zone (USDA-ERS 2013). There is a greater degree of variation among counties in this zone. Three Washington and the one Idaho county are all classified as small metropolitan counties.

Table 37 shows the urban-rural classifications for counties in the Wallowa-Whitman socio-economic impact zone (USDA-ERS 2013). Like the Malheur socio-economic impact zone, this area is entirely nonmetropolitan. Both Baker and Union counties are home to cities (Baker City and La Grande, respectively) that contain about half of their respective populations. These cities provide economic, educational, and cultural opportunities to residents of the Wallowa-Whitman socio-economic impact zone.

Table 36. Urban-rural classification, Umatilla Socio-Economic Impact Zone

County	Code	Description
Grant, OR	9	Nonmetro - Completely rural or less than 2,500 urban population, not adjacent to a metro area
Morrow, OR	6	Nonmetro - Urban population of 2,500 to 19,999, adjacent to a metro area
Umatilla, OR	4	Nonmetro - Urban population of 20,000 or more, adjacent to a metro area
Union, OR	7	Nonmetro - Urban population of 2,500 to 19,999, not adjacent to a metro area
Wallowa, OR	9	Nonmetro - Completely rural or less than 2,500 urban population, not adjacent to a metro area
Wheeler, OR	9	Nonmetro - Completely rural or less than 2,500 urban population, not adjacent to a metro area
Asotin, WA	3	Metro - Counties in metro areas of fewer than 250,000 population
Columbia, WA	3	Metro - Counties in metro areas of fewer than 250,000 population
Garfield, WA	8	Nonmetro - Completely rural or less than 2,500 urban population, adjacent to a metro area
Walla Walla, WA	3	Metro - Counties in metro areas of fewer than 250,000 population
Nez Perce, ID	3	Metro - Counties in metro areas of fewer than 250,000 population

Source: U.S. Department of Agriculture, Economic Research Service 2013

Table 37. Urban-rural classification, Wallowa-Whitman Socio-Economic Impact Zone

County	Code	Description
Baker, OR	7	Nonmetro - Urban population of 2,500 to 19,999, not adjacent to a metro area
Union, OR	7	Nonmetro - Urban population of 2,500 to 19,999, not adjacent to a metro area
Wallowa, OR	9	Nonmetro - Completely rural or less than 2,500 urban population, not adjacent to a metro area

Source: U.S. Department of Agriculture, Economic Research Service 2013

Household Income

Income is an indicator of economic well-being in an area. It shows the capability of the population to consume goods and services and potentially save for the future. Median household income across the socio-economic impact zones is largely below state and national averages (Figure 4). Eleven out of the thirteen counties have lower median household incomes than their state averages (Umatilla County, OR and Garfield County, WA have higher income levels than state averages). Umatilla County has the highest median household income of $57,929, compared to an Oregon median income of $50,521 in 2014. Grant, Harney and Wheeler counties in Oregon all had median household incomes below $40,000 in 2014 (Census 2014). With the majority of income levels lower than state averages, people in the socio-economic impact zones may have fewer resources to adapt to economic change. Therefore, Forest Service management actions that affect economic opportunities may be acutely felt by low-income populations in the socio-economic impact zones.

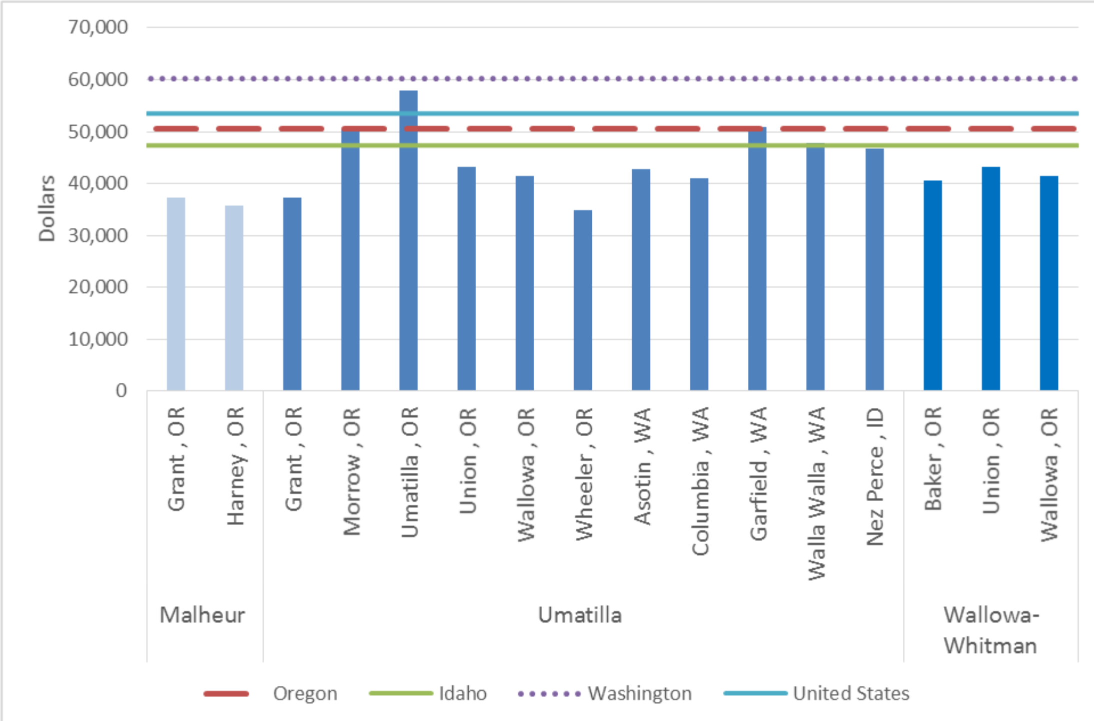


Figure 4. Median household income, 2014

Source: U.S. Department of Commerce, Census Bureau, 2010-2014 American Community Survey 5-Year Estimates (Table DP03)

Employment and Income by Sector

Jobs and income are a major concern for many stakeholders. After the release of an earlier draft of the Blue Mountains Forest Plan, stakeholder comments included: "This plan does not adequately address the significance of this federal action on the human environment which includes the local communities surrounding these federal forests. The plan does not address the stagnation in the economies, the inability for the local counties to tax this land to sustain services for the local communities, the local school district that depend on the revenue sharing that historically came from the timber sales on the national forests or the rise in poverty in the region. The Northeast Oregon region is also experiencing a decline in family-wage jobs which is driving the younger generation to urban [areas] in order to obtain a job."

After analyzing many comments on the draft Blue Mountains Forest Plan Revision and Environmental Impact statement, the Forest Service re-examined employment and income data by sector to provide indications of the relative importance of industries in the socio-economic impact zones and how those industries have changed between 2001 and 2014. A comparison of employment and income concentration is designed to reveal which types of jobs are high paying.

National forest management activities and the production of goods and services affect businesses within a number of sectors. Recreation expenditures contribute directly to lodging and restaurants in the accommodation and food services as well as retail trade sectors; timber production contributes directly to logging in the agriculture and forestry as well as manufacturing sectors; forage production contributes directly to ranching in the agriculture sector; and agency budgets contribute directly to a number of different businesses in addition to directly providing public sector employment opportunities. Agency investments in forest restoration, such as Eastside Restoration, contribute to the sustainability of forestry-related sectors. These businesses help the

Forest Service to sustain and restore the ecological integrity of the national forests as well as provide the public with opportunities to use and enjoy forest resources. For example, when logging and wood processing facilities are located in communities near the national forests it reduces the cost of ecosystem restoration activities, such as thinning. Without hospitality businesses to provide goods and services to out-of-town visitors, it would be more difficult for people to recreate on the national forests.

The job and income information presented here is from IMPLAN model data primarily based on the U.S. Census County Business Patterns, Bureau of Labor Statistics Covered Employment and Wages Program, and Bureau of Economic Analysis Regional Economic Information System. The data are organized by industry or industry group using the North American Industrial Classification System (NAICS). The employment data includes both full- and part-time jobs, and the income data includes wages and proprietor income. Estimates for the self-employed are included, which is important in the logging industry. Income data for 2001 is converted to 2014 dollars using gross domestic product price deflators.

The Malheur socio-economic impact zone employment picture is changing (see Figure 5). In 2001, the agriculture, forestry, fishing, and hunting sector provided the most full- and part-time jobs followed closely by the government sector, with each providing more than 2,000 jobs. Both continued to be the largest sectors in 2014, though by this point government employment surpassed agricultural employment. State and local employment comprised about 71 percent of all government jobs in 2014 (IMPLAN 2014). The services sectors also provided a large amount of employment.

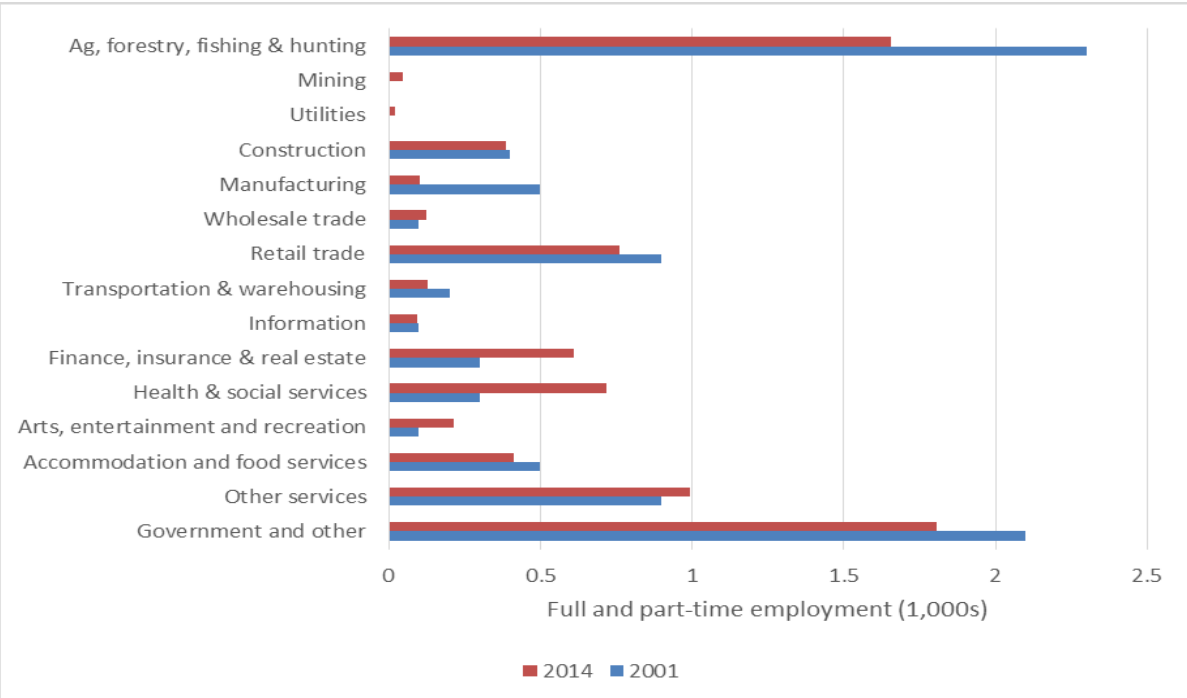


Figure 5. Employment by industry for the Malheur socio-economic impact zone, 2001 and 2014

Income by industry for the Malheur socio-economic impact zone shows the dominance of the government sector (see Figure 6). About 50 percent of all labor income occurs in the government sector. There were declines in income for many sectors. However, there was an increase in the health and social services, finance information, agriculture, and other services sectors.

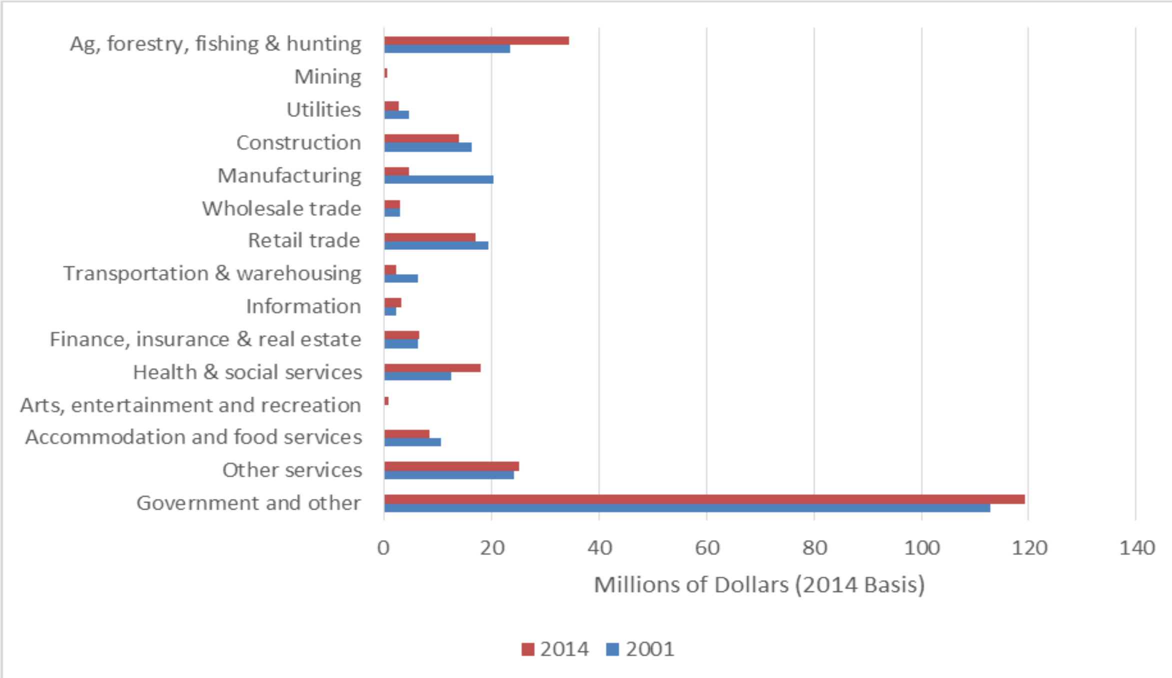


Figure 6. Labor income by industry for the Malheur socio-economic impact zone, 2001 and 2014
Source: IMPLAN 2001 and IMPLAN 2014

Employment within the Umatilla socio-economic impact zone is not dominated by one or two sectors (see Figure 7). Employment is more evenly spread across several sectors providing less dependence on a single industry. Similar to the Malheur socio-economic impact zone, there were declines in employment for most sectors and increases in government and health and social services. Government makes up less than 20 percent of all employment. State and local employment comprised about 85 percent of all government jobs in 2014.

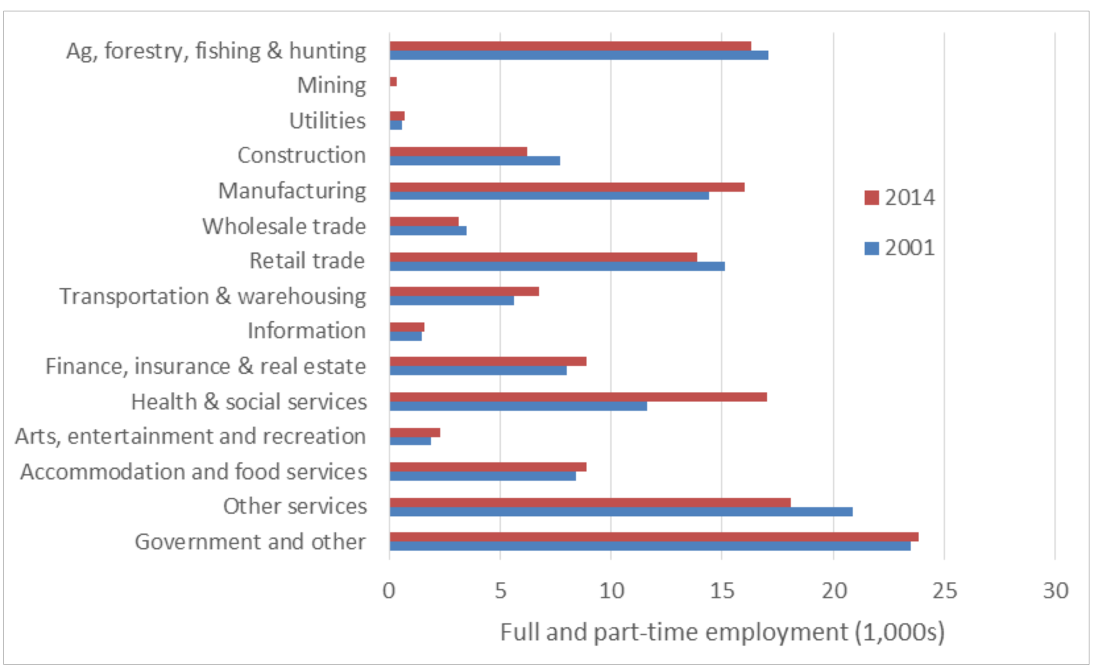


Figure 7. Employment by industry for the Umatilla socio-economic impact zone, 2001 and 2014

Source: IMPLAN 2001 and IMPLAN 2014

Although income by industry for the Umatilla socio-economic impact zone shows the dominance of the government sector with nearly 25 percent of all labor income, the rest of the income is distributed fairly evenly across several sectors (see Figure 8). Unlike the Malheur socio-economic impact zone, there were general increases in income for most sectors. Declines were pronounced in the manufacturing sector.

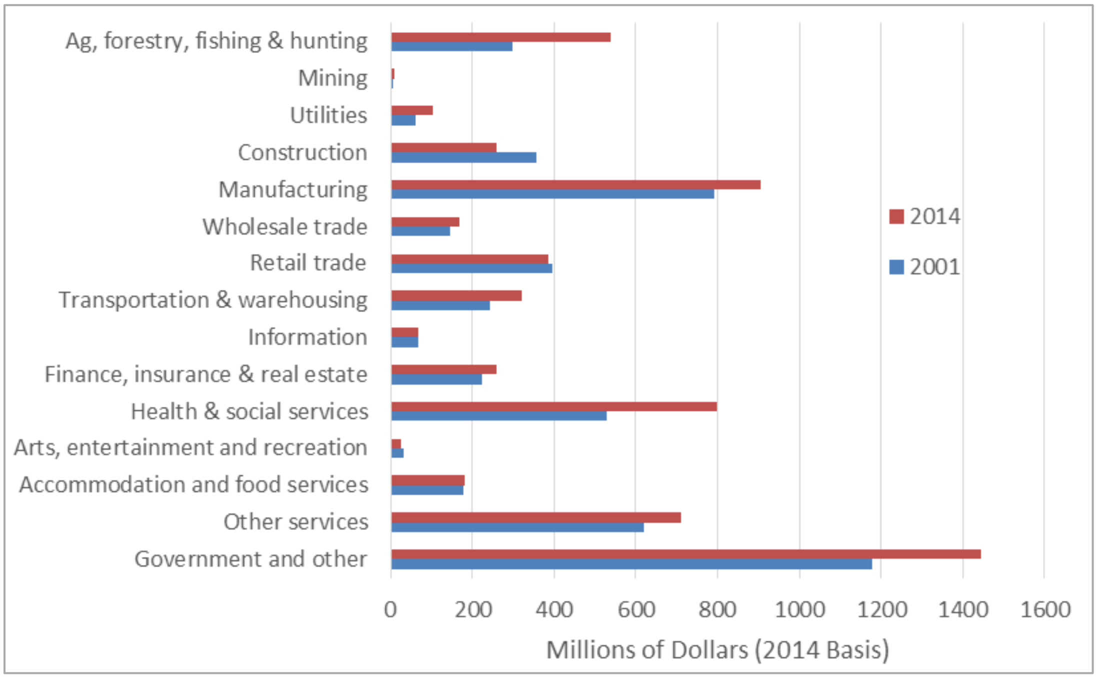


Figure 8. Labor income by industry for the Umatilla socio-economic impact zone, 2001 and 2014
Source: IMPLAN 2001 and IMPLAN 2014

The distribution of employment within the Wallowa-Whitman socio-economic impact zone is similar to the Umatilla socio-economic impact zone in that it is more evenly spread across several sectors providing less dependence on a single industry (see Figure 9). Similar to the Malheur socio-economic impact zone, there were declines in employment for most sectors. However, in this socio-economic impact zone, government employment did not increase. The most prominent increases were in health and social services and transportation and warehousing sectors. The government sector contributes slightly less than 15 percent of all employment. State and local employment comprised about 82 percent of all government jobs in 2014.

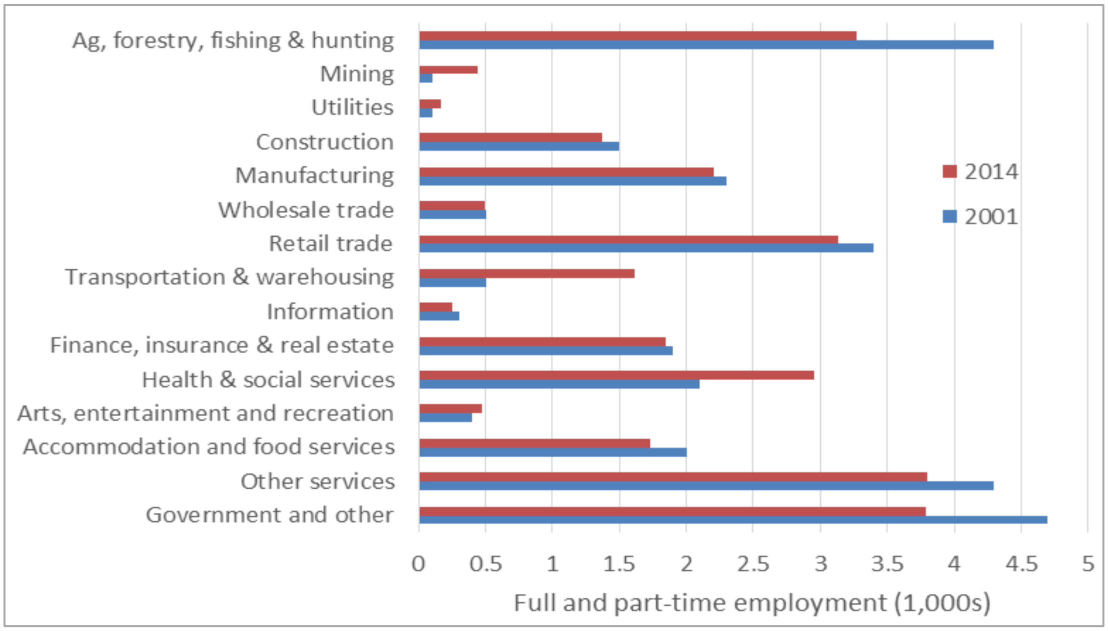


Figure 9. Employment by industry for the Wallowa-Whitman socio-economic impact zone, 2001 and 2014

Source: IMPLAN 2001 and IMPLAN 2014

There is a mix of increases and decreases with regards to the income by industry within the Wallowa-Whitman socio-economic impact zone. Health and social services and transportation and warehousing show sizeable increases in income (see Figure 10). The dominance of the government sector is similar to the Umatilla socio-economic impact zone with approximately 25 percent of all labor income. The rest of the income is distributed fairly evenly across several sectors. Declines were notable in the construction, manufacturing, and accommodations and food services sectors.

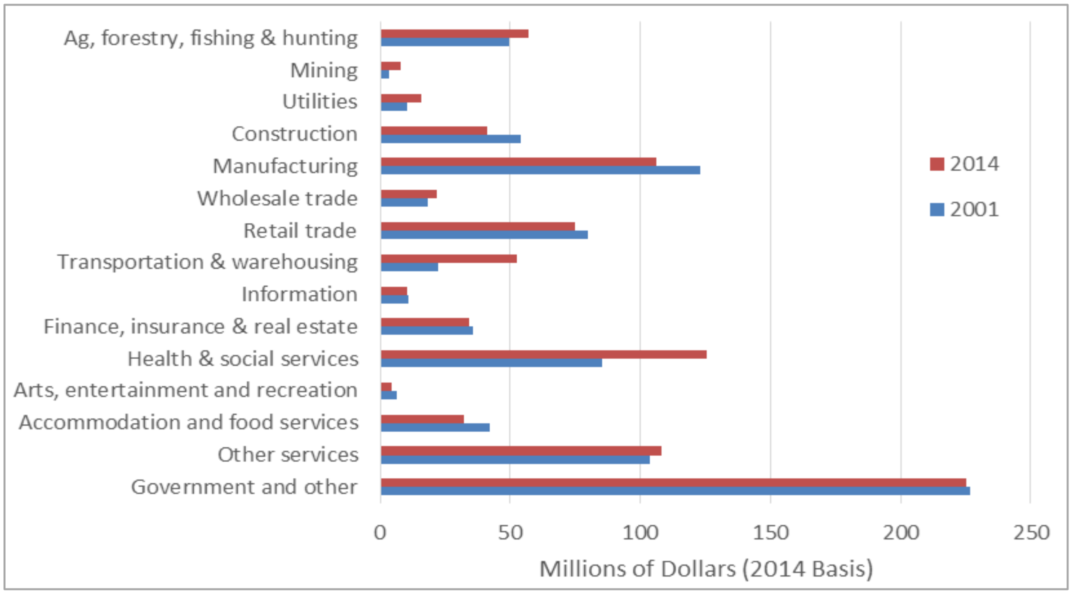


Figure 10. Labor income by industry for the Wallowa-Whitman socio-economic impact zone, 2001 and 2014

Source: IMPLAN 2001 and IMPLAN 2014

Economic Diversity

A diverse economy with varied employment opportunities can better withstand economic change. Specialized economies with dependence on a few industries for employment and income are less resilient to local changes and national fluctuations. A Shannon-Weaver diversity index is used to indicate the degree of economic specialization (IMPLAN 2014). The index ranges from zero, the most specialized, to one, the most diverse. Table 38 displays the diversity index of the three socio-economic impact zones and Oregon. The state's index is highest since it represents a diverse, statewide economy. The Malheur socio-economic impact zone has the lowest diversity index and may be the least resilient to economic change.

Table 38. Economic diversity in Oregon and the socio-economic impact zones, 2014

Area	Diversity Index
Oregon State	0.77
Malheur Socio-Economic Impact Zone	0.64
Umatilla Socio-Economic Impact Zone	0.75
Wallowa-Whitman Socio-Economic Impact Zone	0.72

Source: IMPLAN 2014

Unemployment

Ten out of the thirteen counties in the socio-economic impact zones had unemployment rates above their state and national averages in 2014. Grant and Wallowa Counties had unemployment rates well above state and national averages at 10.5 and 10 percent, respectively (Figure 11). Nez Perce County, ID (4.1 percent) and Asotin County, WA (5.3 percent) had the two lowest unemployment rates in the socio-economic impact zones. High rates of unemployment occur for a variety of reasons, including shifts in resource extraction and technological change.

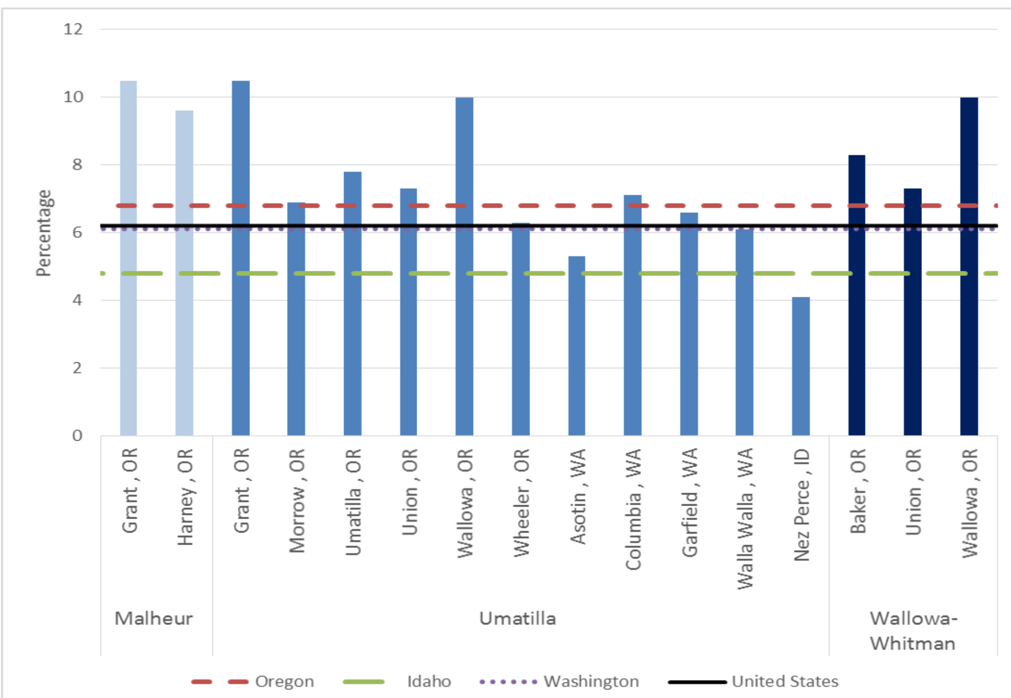


Figure 11. Unemployment rate in socio-economic impact zones, 2014
Source: U.S. Bureau of Labor Statistics, Local Area Unemployment 2014

Community Resilience

Community (or socioeconomic) resilience relates to humans' ability to adapt to social and economic changes. Beckley et al. (2002) define community resilience as: "the capacity of humans to change their behavior, redefine economic relationships, and alter social institutions so that economic viability is maintained and social stresses are minimized." This section evaluates indicators that are linked to human well-being and resilience. Recent evidence suggests that the well-being of individuals like those in many of the communities that surround the Blue Mountains national forests are in decline. For example, recent research by Anne Case and Angus Deaton on national trends notes:

> Changes in society…made life more difficult for less-educated people, not only in their employment opportunities, but in their marriages, and in the lives of and prospects for their children. Traditional structures of social and economic support slowly weakened; no longer was it possible for a man to follow his father and grandfather into a manufacturing job, or to join the union. Marriage was no longer the only way to form intimate partnerships, or to rear children. (Case and Deaton 2017)

Stakeholders in the three socio-economic impact zones expressed beliefs about the relationship between Forest Service management activities and local community resilience. Some think that Forest Service management activities contribute to a lack of utilization of forest resources that affect community resilience in terms of lost jobs and poverty levels. Some public sentiment is that the Forest Service should support maintenance of permanent community infrastructure with living-wage jobs and offer an opportunity to build upon community resilience rather than just scenery and old forests. They believe that the reductions in access, recreation opportunities, timber harvest, and grazing are negatively affecting community resilience. Therefore the opinions are more along the line that the Forest Service should increase these activities and not limit them. Stakeholder comments included:

> Many of the factors that contribute to community resiliency are beyond the control of communities, counties, states, and the Federal government, including the Forest Service . . . The USFS has control over the local resident's ability to access resources to increase their resiliency . . . The proposed action currently identifies a desired condition to [severely] reduce motorized use in the Blue Mountains. This will make remote communities less resilient to changing ecological, social and economic conditions. Fewer means to access public lands decrease accessibility to needed resources and infrastructure in rural communities, further limiting their ability to access resources they need to survive.

Some stakeholders who are concerned about sustaining local educational, law enforcement and health services believe that the Forest Service should transfer an equal number of acres to local counties for every new acre of land set aside as wilderness in order to sustain economic development. Stakeholder comments included:

> I recommend that for each acre placed in new wilderness or scenic river designation, that an equal acreage of forest service land be transferred to local counties. This would enable local counties to manage that land in such a manner as to sustain local economic development thereby sustaining local educational, law enforcement and health services while at the same time serving vacationers from economic areas which are not based upon our regional based economies.

As a result of stakeholder input to the Draft Environmental Impact Statement, this section has been added to this document to further evaluate data related to community resilience including

educational attainment, health, and crime, which reveals that people are in distress across all three socio-economic impact zones.

Education

Nationally, 86 percent of the US population over 25 years of age was a high school graduate or equivalent in 2014. Oregon, Idaho and Washington all have slightly higher rates of high school graduates at 89-90 percent of the 25 years or older population. All but two counties in the study region have high school educated populations above the national average. Garfield County, WA has the highest portion at 97 percent, and Wallowa County, OR the second highest portion at 93 percent. Morrow County, OR fell below the national average and had the lowest share of high school educational population at 76 percent of the population 25 years and older. Umatilla County, OR also fell below national average at 83 percent.

Conversely, all the counties in the study region had rates of college and postgraduate educational attainment below the national and their respective state averages. Morrow and Umatilla counties in Oregon had the lowest portion of population with Bachelor’s degree at 8 and 10 percent, respectively. This compares to 18 percent nationally and 19 percent statewide in Oregon. Garfield County, WA had the highest portion, with 18 percent college educated. Post graduate education rates show a large degree of variation across the study region. Morrow County, OR again had the lowest portion at 2 percent, while Wallowa County, OR and Walla Walla County, WA both had over 10 percent of the 25 years and older population with a graduate or professional degree in 2014.

This pattern of above average high school graduation rates and below average college and postgraduate rates is a nationally occurring distinction between urban and rural areas and the gap in rates of college educated adults between urban and rural areas has only grown over time (USDA-ERS, 2016). Education is an important component of human capital that can increase the capability of a community to adapt to complex issues associated with social and economic change. Educational attainment is linked to income levels, unemployment, and poverty rates, where individuals with higher levels of education have higher earning potential and lower rates of unemployment. In addition, rural counties with higher levels of average education were found to have experienced faster job growth following the most recent recession (Marre 2014). Additionally, as documented above, higher educational attainment is linked to better health outcomes (Case and Deaton 2017).

Health

Nationally, 86 percent of the U.S. population had health insurance in 2014 (Figure 12). The share of the population in Oregon with health insurance is nearly identical. Washington State had a slightly higher rate, 87 percent, while Idaho State was below at 84 percent of their state population with health insurance coverage. Coverage rates varied across the counties in the study area ranging from 83 percent in Umatilla and Morrow counties in OR, to 90 percent in both Columbia and Garfield counties in Washington. Six out of 13 counties in the socio-economic impact zones had lower portions of their populations with health insurance than their respective states. Health insurance is an indicator of social well-being and is coupled with higher than average unemployment rates and children living in poverty. Some communities in the socio-economic impact zones are facing significant challenges and are looking for opportunities to improve local social conditions.

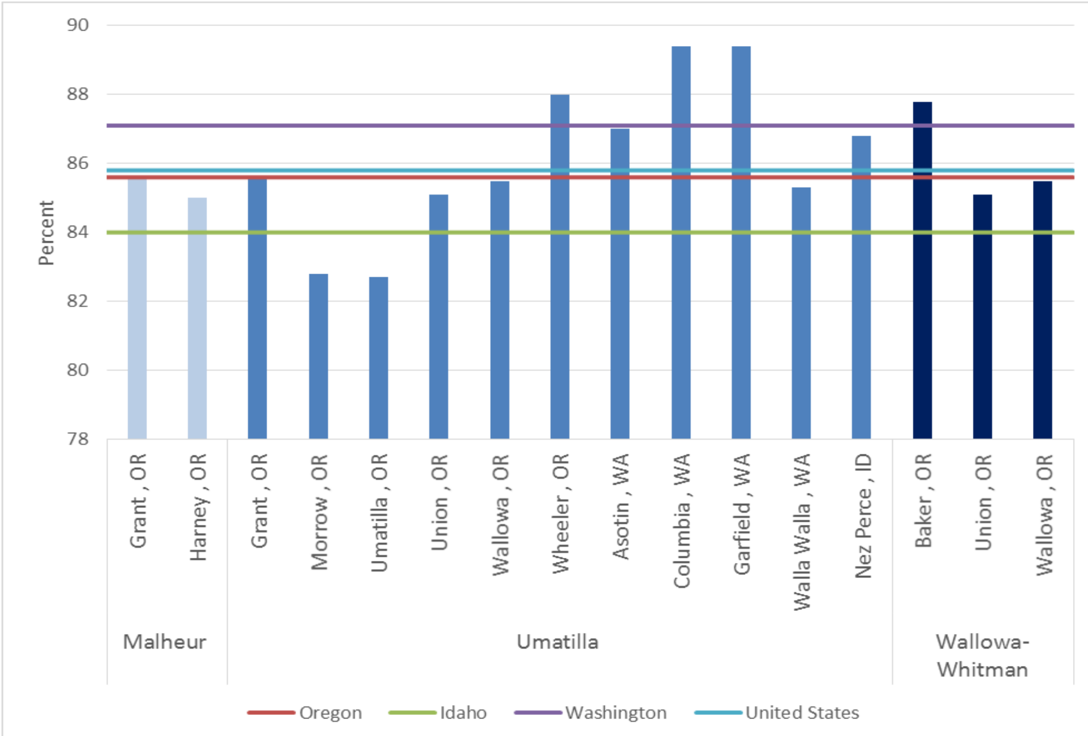


Figure 12. Percentage of population with health insurance coverage, 2014

Source: U.S. Department of Commerce, Census Bureau, 2010-2014 American Community Survey 5-Year Estimates (Table DP03)

Smoking and obesity rates also signify the health and social well-being of populations. Nationally smoking rates were higher for males than for females (22.2 percent of males and 17.9 percent of females smoked in 2012) (Figure 13). In the socio-economic impact zones, smoking rates among males and females are generally above national averages. Garfield and Walla Walla counties in Washington were the exception with smoking rates for both males and females below national rates. In all counties in 2011, obesity rates were higher for both males and females than the national averages (Figure 14). With lower than average health insurance coverage, higher rates of smoking prevalence and obesity, people in the socio-economic impact zones have a higher risk of smoking and obesity related illness that could be left untreated without health insurance. This can limit their ability to contribute to the economy and social infrastructure that makes a community resilient to change.

Case and Deaton (2017) find that mortality and morbidity rates among middle aged non-Hispanic whites are rising. Non-Hispanic whites with less than a college degree are driving the increase in middle aged mortality (Case and Deaton 2017). They find that “deaths of despair” – due to alcohol, drugs, and suicide – have increased dramatically among middle aged non-Hispanic whites without a college education (Case and Deaton 2017).

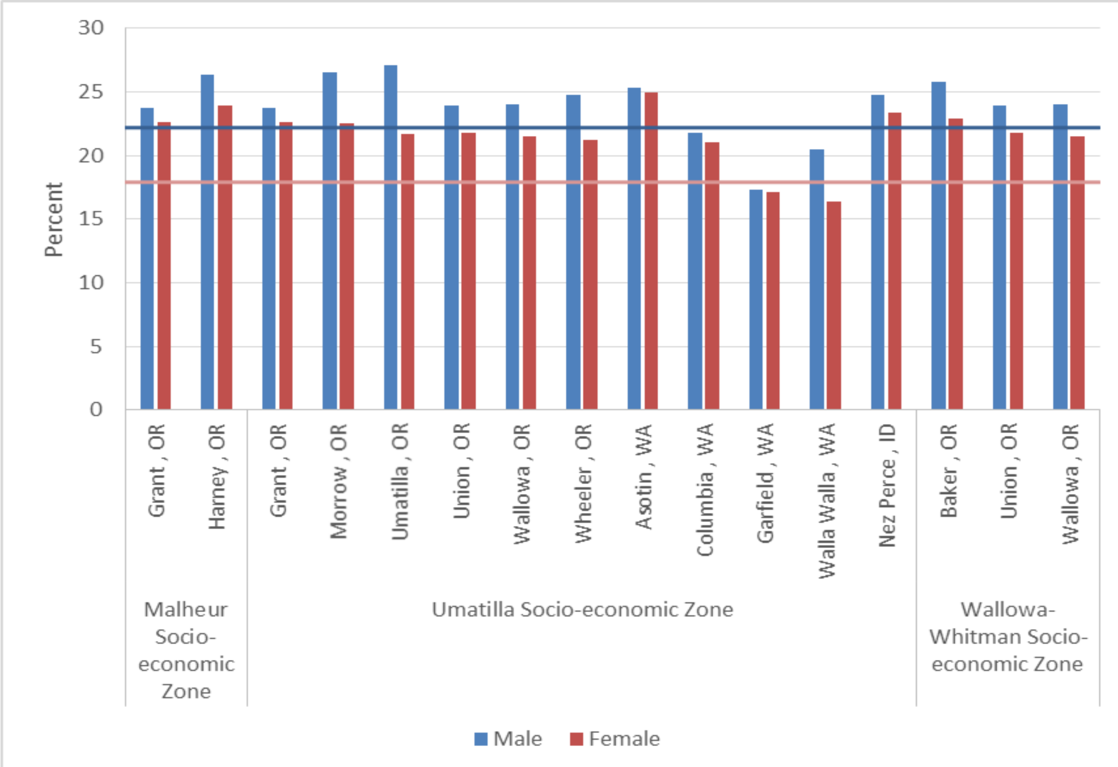


Figure 13. Smoking prevalence, by gender, 2012

Source: Institute for Health Metrics and Evaluation (IHME), US County Profile: multiple counties. Seattle, WA, 2015.

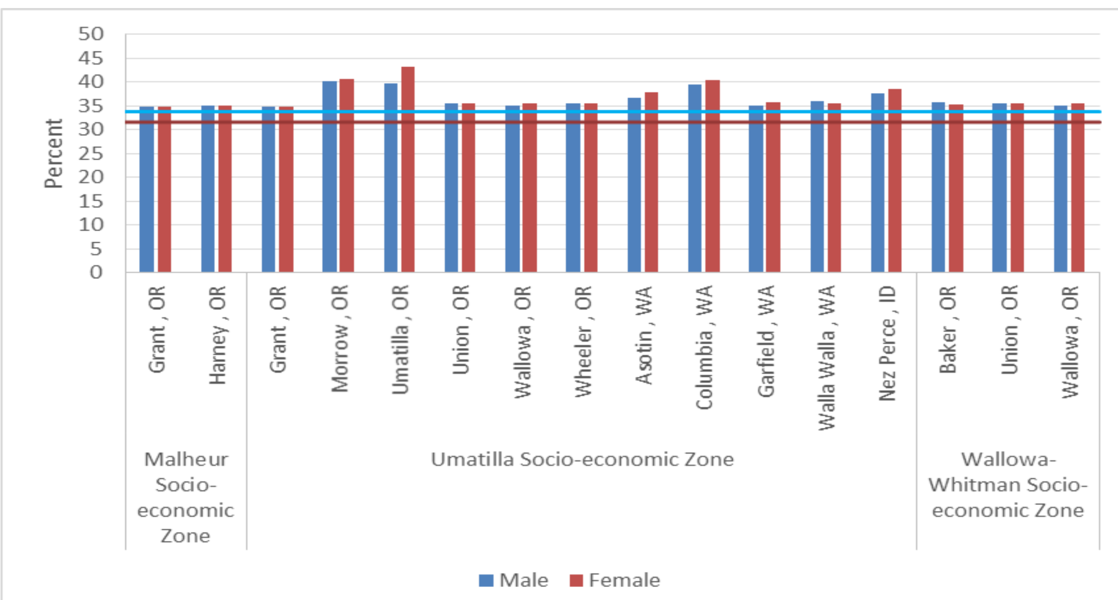


Figure 14. Obesity prevalence, by gender, 2011

Crime

Crime is another indicator of the social conditions of an area. Total violent crimes (includes murders, forcible rapes, robberies, and aggravated assaults) ranged from 0.1 per 1,000 population in Grant County, OR to 3.1 per 1,000 in Garfield County, WA. These rates are below the

nationwide rate of 3.9 per 1,000. Property crimes reported (burglaries, larcenies and motor vehicle thefts) varied dramatically between counties in 2012. Baker County, OR had a rate of 4.7 per 1,000, and Umatilla County, OR a rate of 34.1 per 1,000 persons. The national rate of property crimes reported in 2012 was 28.6 per 1,000. Juvenile and adult arrests showed similar variation across the study area with some counties well below state and national rates and some counties well above (Figure 15). Unemployment and poverty are often associated with higher crime rates and changes in social conditions have the potential to affect crime rates.

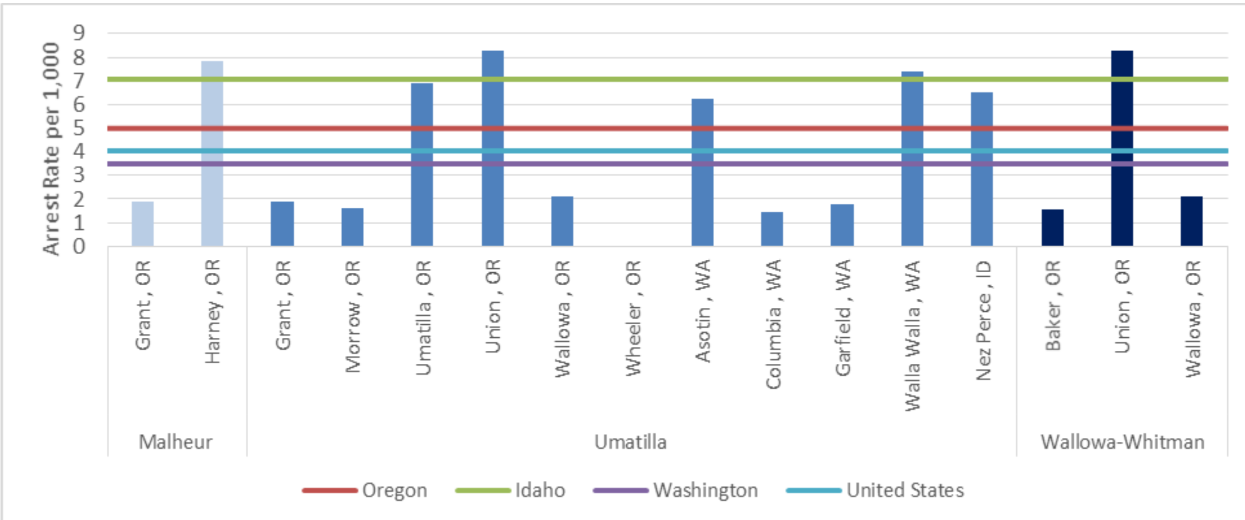


Figure 15. Arrests per 1,000 people

Source: United States Department of Justice. Federal Bureau of Investigation. Uniform Crime Reporting Program Data: County-Level Detailed Arrest and Offense Data, 2012. ICPSR35019-v1. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2014-06-12. http://doi.org/10.3886/ICPSR35019.v1

Community Resilience Summary

All of these indicators show the social and economic conditions present in the socio-economic impact zones, which can also be used to explain the ability of a community to adapt to change, known as socioeconomic or community resilience (Daniels 2004). Public comments and issues expressed through the collaborative process revealed that people are concerned about retaining the social and economic benefits from forest lands in the area. One of the main issues is sustaining harvest and resulting jobs in the timber market. Furthermore, it is important to link these social and economic values and show how they influence the community's ability to adapt to changes in Forest Service resource management (e.g., changes in the timber supply). "Managing national forests for the sustainable production of timber, biomass, non-timber forest products, and forage for livestock can help support forest-based livelihoods in parts of the region where they are socially and economically important, thereby contributing to social and economic sustainability and community resilience" (Charnley and Long 2014).

Public comments discussed the ability of the Forest Service to contribute to community resilience. Comments from the public include the belief that:

> Many of the factors that contribute to community resiliency are beyond the control of communities, counties, states, and the Federal government, including the Forest Service . . . The USFS has control over the local resident's ability to access resources to increase their resiliency.

Indicators for resilience are not fully developed but it is important to consider the factors that could influence how a community responds to changes in the management of forest resources. Indicators of community resilience include various social and economic characteristics, such as cohesiveness, infrastructure, cultural and economic diversity, resource dependence, attractiveness to business, quality of life, and civic leadership. Communities that have diverse social and economic characteristics are likely more resilient to change (Daniels 2004).

Economic diversity increases as the type of jobs in the area increases. With more types of jobs available, an economic shock to one industry will not have as great of an effect on the economy as a whole. Land management actions that contribute a diversity of jobs to the area, as opposed to only providing jobs in the timber sector, are expected to increase community resiliency. For example, improved forest health can result in jobs in real estate, recreation, construction, and manufacturing from people moving to the area for the natural amenities.

Industries customarily served by agency land uses, such as logging, wood products manufacturing, and livestock grazing, may no longer dictate the economic prosperity of the socio-economic impact zones, but they remain economically and culturally important. The economic dependence of communities on these industries is highest in areas that are geographically isolated with few alternative employment opportunities.

In addition, the social structure and organization of the community also contribute to the resiliency of the community to change. In the Blue Mountains, there are multiple Forest Service collaborative groups that serve to bring community members together and provide a forum to discuss solutions to land management challenges. Included are the Blue Mountain Forest Partners, Harney County Restoration Collaborative, Ochoco Forest Restoration Collaborative, Umatilla Forest Collaborative Group, Wallowa County Resources, and the Wallowa-Whitman Forest Collaborative. The Wallowa County Natural Resource Advisory Committee (NRAC) also serves to be representative of Wallowa County interest groups. These groups reinforce the social organization and collaborative process of the community. Other social organizations in the community with multiple stakeholders are the watershed councils that are part of the Oregon Watershed Enhancement Board in the region, such as the Umatilla Basin Watershed Council, North Fork John Day Watershed Council, Crooked River Watershed Council, Walla Walla Watershed Council, and Powder Basin Watershed Council.

Low levels of income, employment diversity, education, health insurance coverage, and declining and aging populations are all indicators of low community resiliency. This limits the ability of the community to adapt to changes in the local economy, such as shifts from timber extraction to natural amenities that support a recreation economy. However, the social fabric of the socio-economic impact zones is tied together by shared values for their public land. Importantly, many people value the timber resources that have sustained their economy and supported their families for generations and want to continue this way of life. Ranching is deeply ingrained in local communities, both for its economic contribution and cultural tradition. People also value opportunities for subsistence (e.g., fuelwood gathering, hunting and fishing) and recreation. Ensuring the ecological integrity of the Blue Mountains national forests are also important to community members, such as those engaged in the Hells Canyon Preservation Council. These are the existing social and economic conditions of the socio-economic impact zones that could be affected by planning activities for National Forest System lands in the Blue Mountains.

Sense of Place

Sense of place describes how individuals or groups identify and value a place. There is a common understanding of how the resources of their place should be managed, and a common understanding of how things are normally done. People's identification with places sometimes comes from personally interacting with those places and experiencing them with one's senses. For many people, sense of place is anchored in working in the timber industry or in ranching, restoration, or recreation related jobs on public lands. For others, sense of place involves a hunting camp that is used annually by a group of longtime friends, a rural community that hosts pancake feeds to fund fire protection projects, a grazing allotment dotted with old homestead sites whose natural springs provide water even during droughts, and areas that have traditional importance to Tribes for gathering, hunting, and spiritual renewal.

Sense of place can also describe an appreciation of and an attachment to a place that has not been experienced first-hand. Examples include people who support conservation efforts but have never visited the place they support conserving. Those who value the existence of cowboys or wilderness areas, but have never encountered them personally, could be described in this category.

In summary, James Kent and Associates characterize the key values expressed by many of the residents of the Blue Mountains area in the following statement:

> The people in the Blue Mountains Social Resource Unit are extremely outdoor oriented in work and play, linked to the core with grazing, agriculture and timber management. They have created communities which are relatively safe and family-oriented, and which comfortably absorb newcomers who make an effort to fit in. Residents pride themselves on self-sufficiency and interdependence and want government influence to be practical, effective, and minimal. (James Kent and Associates 2006)

Although the statement was specific to residents in a subset of all the counties addressed in the socio-economic impact zones, it generally fits throughout. Stakeholder comments included, "Forests are more valuable when they are protected from logging than when they are logged … Conserved forests contribute to our quality of life, which is one of the most valuable economic development assets we have."

Subsistence uses, or the ability to get materials for survival, from national forests contribute to how people connect with the land. People value subsistence opportunities on national forests and believe it contributes to their well-being. Therefore, they have positive attitudes towards open access to the forest land. Stakeholder comments asked that the Forest Service consider "subsistence needs as an attribute of social well-being and community resilience. Such needs include access for firewood and other resources."

Environmental Justice

In 1994, President Clinton issued Executive Order 12898 (Office of the President 1994). This order mandates that all Federal agencies analyze the potential for their actions to disproportionately affect minority and low-income populations. The Council on Environmental Quality (CEQ) issued supplemental guidance to assist agencies' compliance (CEQ 1997). The CEQ suggests the following criteria for identifying potential Environmental Justice populations:

> Minority population: Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50 percent or (b) the minority population

> percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis...
>
> Low-income population: Low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the Bureau of the Census' Current Population Reports, Series P-60 on Income and Poverty. In identifying low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect.

All but two counties in the socio-economic impact zones have a larger percentage of white, non-Hispanic or Latino populations, and correspondingly smaller percentages of minority populations than state and national averages (Table 39). Morrow and Umatilla counties (OR) are notable exceptions with the portion of Hispanic or Latino populations more than twice their state average. Walla Walla County, WA also has a higher percentage of Hispanic or Latino greater than the state average. These areas with higher than average Latino populations are considered environmental justice populations.

Table 39. Share of minority population, by county

Malheur Socio-Economic Impact Zone	Percent of Population White, Non-Hispanic or Latino	Percent of Population Hispanic or Latino (any race)
Grant County, OR	92.6	3.2
Harney County, OR	88.2	4.4
Umatilla Socio-Economic Impact Zone	**Percent of Population White, Non-Hispanic or Latino**	**Percent of Population Hispanic or Latino (any race)**
Grant County, OR	92.6	3.2
Morrow County, OR	62.8	33.2
Umatilla County, OR	68.2	24.9
Union County, OR	90.1	4.2
Wallowa County, OR	93.9	2.5
Wheeler County, OR	92.7	3.5
Asotin County, WA	91.9	3.4
Columbia County, WA	89.0	6.2
Garfield County, WA	91.6	5.2
Walla Walla County, WA	73.1	20.6
Nez Perce County, ID	87.9	3.2
Wallowa-Whitman Socio-Economic Impact Zone	**Percent of Population White, Non-Hispanic or Latino**	**Percent of Population Hispanic or Latino (any race)**
Baker County, OR	92.1	3.7
Union County, OR	90.1	4.2
Wallowa County, OR	93.9	2.5
Oregon	77.6	12.1
Idaho	83.3	11.7
Washington	71.3	11.7
United States	62.8	16.9

Source: U.S. Department of Commerce, Census Bureau, 2010-2014 American Community Survey 5-Year Estimates (Table DP05)

Many counties across the three socio-economic impact zones experience higher poverty rates than their respective states (see Table 40). Poverty rates are not reported by race or ethnicity because small sample sizes in the counties mean that these estimates are not reliable below the state-level. However, minority populations typically experience higher rates of poverty than non-Hispanic/Latino white populations. In Idaho, Oregon, Washington, and the United States black, Native American, and Hispanic/Latino populations are much more likely (approximately twice as likely) to live in poverty than non-Hispanic/Latino whites. The high poverty rates indicate the potential for environmental justice effects.

Table 40. Poverty rates, by county

Malheur Socio-Economic Impact Zone	Percent of People in Poverty
Grant County, OR	15.4
Harney County, OR	21.1
Umatilla Socio-Economic Impact Zone	**Percent of People in Poverty**
Grant County, OR	15.4
Morrow County, OR	19.3
Umatilla County, OR	17.1
Union County, OR	18.8
Wallowa County, OR	13.9
Wheeler County, OR	18.3
Asotin County, WA	15.3
Columbia County, WA	17.5
Garfield County, WA	12.4
Walla Walla County, WA	16.7
Nez Perce County, ID	11.7
Wallowa-Whitman Socio-Economic Impact Zone	**Percent of People in Poverty**
Baker County, OR	18.3
Union County, OR	18.8
Wallowa County, OR	13.9
Oregon	16.7
Idaho	15.6
Washington	13.5
United States	15.6

Source: U.S. Department of Commerce, Census Bureau, 2010-2014 American Community Survey 5-Year Estimates (Table S1701)

It is useful to see the percentage of children (under 18) living in poverty to understand the challenges faced in the socio-economic impact zones. Ten out of thirteen counties in the socio-economic impact zones have higher levels of children living below the poverty level than for their respective states (Figure 16). Over a third of people under 18 years live below the poverty level in Harney County which is above the state and national rate of 22 percent. Baker, Wheeler, Morrow and Umatilla counties in Oregon were also above state and national averages while Wallowa County, OR and Nez Perce County, ID had the lowest rates of child poverty at 16 percent. Children are growing up poor in the socio-economic impact zones, which limits their access to

education and employment opportunities. These high-poverty areas are considered environmental justice populations.

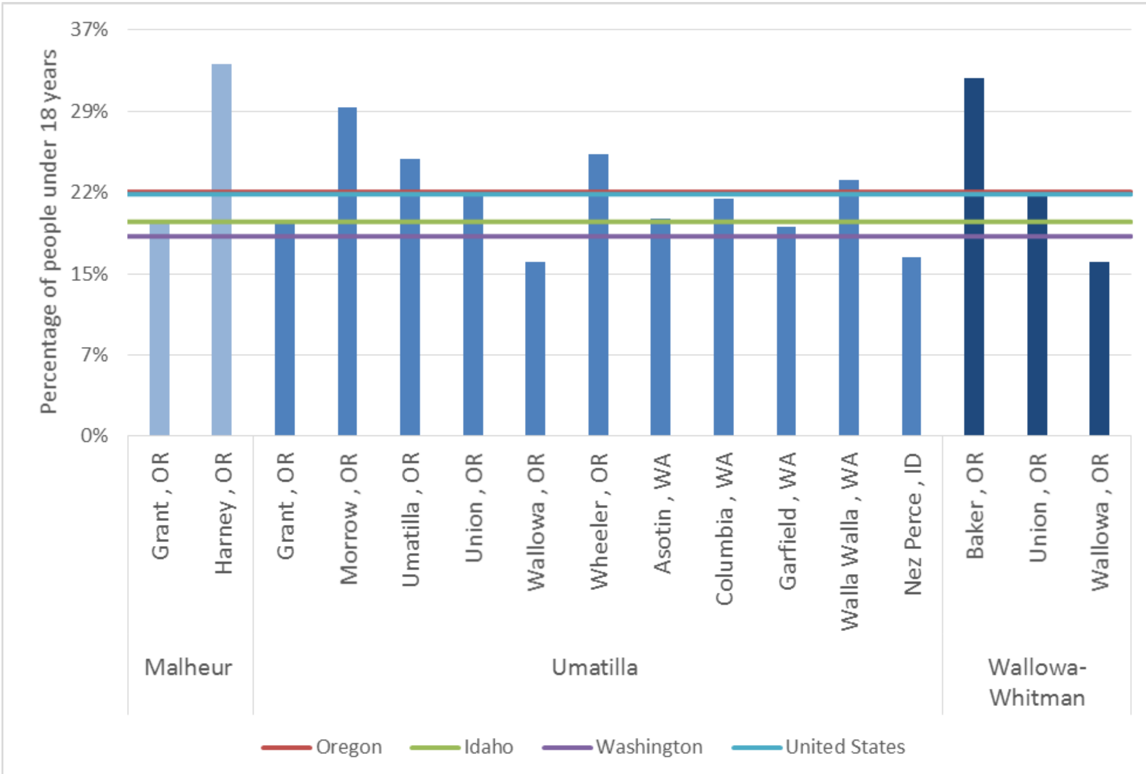


Figure 16. Percentage of children (under 18) below poverty level, 2014

Source: U.S. Department of Commerce, Census Bureau, 2010-2014 American Community Survey 5-Year Estimates (Table DP03)

Values, Attitudes, Beliefs

This section presents a summary of values, attitudes, and beliefs related to the Blue Mountains Forest Plan Revision. The information comes from written public comments submitted during the Forest Plan Revision process. The values, attitudes, and beliefs assessment is one part of the qualitative social analysis. Quantitative data on community well-being presented in other sections complement this qualitative study. Both the quantitative and qualitative data contribute to the evaluation of the alternatives in terms of issues, community social and economic well-being, and other potential effects on communities.

The Forest Service will make social and economic contributions to communities through our management activities outlined in the Blue Mountains Forest Plan Revision. The Agency attempts to manage Forest Service land to meet as many concerns of our stakeholders as possible, but given the diversity of social and economic needs of the communities, not all needs can always be met. By analyzing stakeholder comments on the Draft Environmental Impact Statement, the Forest Service is gaining a better understanding of the stakeholder perceptions in order to better analyze the effects of its land management. Although all of the values, beliefs, and attitudes are not captured in this analysis, the information received through public comments is the best data available. The public comments are organized into groups based on the issues identified in scoping. These are: access, economic and social well-being, livestock grazing, old forests,

recommended additions to the National Wilderness Preservation System, and ecological resilience.

The definitions of values, attitudes, and beliefs frame the discussion. Values, attitudes, and beliefs are inextricably linked along a continuum. There is overlap among the definitions, which are presented below.

1. Values are “relatively general, yet enduring, conceptions of what is good or bad, right or wrong, desirable or undesirable.”
2. Beliefs are “judgments about what is true or false – judgments about what attributes are linked to a given object. Beliefs can also link actions to effects.”
3. Attitudes are “tendencies to react favorably or unfavorably to a situation, individual, object, or concept. They arise in part from a person’s values and beliefs regarding the attitude object” (Allen et al. 2009).

The majority of letters about the Draft Environmental Impact Statement came from La Grande, Oregon (in Union County). Baker County had the second largest number of comments. Some comments were received by email without a physical addresses. The geographic distribution of comments suggests that stakeholders anticipate that the social and economic effects from the Blue Mountains Forest Plan Revision would occur largely in Union and Baker counties.

Access

Stakeholders are concerned about too few or too many miles available for motor vehicle recreation.

Many stakeholders value access to the public’s lands, whether that access is via motorized vehicles, hiking, biking, pack goats, or any other method to get into national forest land. Some believe that people should be able to access all National Forest System lands by motorized vehicle; others believe that backcountry nonmotorized vehicle areas are important. These beliefs are driven by the varying customary uses of the forest in the Blue Mountains Forest Plan Revision. For example, some people use the forest for gathering fuelwood and picking berries; others use the land for recreation and industrial timber harvest. All of these uses are important to the local community. It is important to consider the range of beliefs about the land management. There are a range of attitudes pertaining to how forest land management actions should affect access. People with different beliefs and attitudes perceive forest land management actions in different ways. They also view effects of the actions differently. For example, people that value access for motorized use would generally have a positive attitude towards maintaining, improving, and expanding existing road networks. On the other hand, people who value access for dispersed backcountry camping would likely have positive attitudes towards designated routes and uses that sustain a quiet natural setting.

Many people commented that they value access to forest lands and want to see existing networks of roads and airstrips maintained. They expressed multiple beliefs about why this important: maintaining cultural and traditional ties to the land, subsistence uses, recreation, and supporting local economies that are all dependent on roads to access the land. These groups would generally have positive attitudes towards actions that maintain current levels of access.

The Forest Service also received comments stating we should maintain the current number of miles of roads. They believe that it is their right to maintain their traditional access to the national forests along the existing road networks for hunting, fishing, cycling, camping, hiking, mining,

mushroom picking, berry picking, firewood gathering, photography, bird watching, wildlife watching, skiing, snowshoeing, motorcycling, riding off-road vehicles, gold panning, and rock hounding.

Some stakeholders expressed concerns over access related to social and economic well-being. They believe that reducing the number of miles of roads on National Forest System lands could hurt local businesses and social stability, impact those who access national forest lands for sustenance, and destroy trust in the Forest Service.

Other stakeholders expressed concern that the Forest Service should not limit access because it will disproportionately affect children, aging populations, wounded veterans, and people with disabilities.

Some comments related to access expressed the belief that the Forest Service should not limit access because it would negatively impact the deep cultural and historic ties communities have to the forests.

Comments related to access expressed beliefs about relationship between availability of forest products and the number of miles of roads on National Forest System lands. These commenters said that the Forest Service should maintain access routes so local residents can gather firewood, berries, and mushrooms, and hunt and fish. Access to these forest products and access to traditionally used locations are important cultural resources for nourishment, income, survival, travel and enjoyment. Similar comments expressed values related to family and tradition.

Many comments expressed beliefs about designated routes. Some commenters believe that the Forest Service should eliminate the need to travel only on designated routes, and that the Forest Service should allow cross country travel to be more access friendly. Other comments stated that user conflict and safety issues could occur as a larger percentage of people are directed into the same areas. Some said the default position should be open roads rather than closed.

Other commenters believe the opposite. They believe that the Forest Service should designate routes to control where and how people travel while accommodating the growing demand for public access to public lands. For example, designated routes could direct off-highway vehicle traffic around sensitive sites.

Some people commented on how much they value solitude and quiet natural places in the Plan Area. They believe that limiting motorized use will provide this opportunity. Some people who value solitude and quiet natural places also believe in the importance of maintaining motorized access, as roads provide them opportunities to access remote trailheads for activities such as hiking and fishing. Other commenters, who value solitude and quiet natural places, believe motorized use would jeopardize the provision of quiet natural places. They would generally have positive attitudes towards actions that restrict access to backcountry for motorized use. For those that believe motorized access provides opportunities to visit quiet places, they would generally have positive attitudes towards actions that maintain existing motorized trails leading to nonmotorized areas.

Comments received on access expressed beliefs related to limiting motorized use. Some comments stated that the Forest Service should preserve large areas for nonmotorized use to provide quiet natural spaces and limit impacts to the quality of hunting, camping, hiking, fishing, backcountry packing, and skiing opportunities. Other comments emphasized nonmotorized access. They said that the Forest Service should increase backcountry nonmotorized areas, close

roads to support the protection of habitat, and prohibit additional cross-country and over-the-snow vehicle travel.

Similar concerns are related to compliance. Some commenters believe that the Forest Service should enforce compliance with regulations for off-highway vehicle use to prevent environmental degradation.

Some stakeholders expressed the belief that the Forest Service should substantially reduce road densities throughout the national forests to protect and restore wildlife corridors, key habitats and ecological processes, and to reduce erosion, impacts on sensitive wildlife and aquatic species, and maintenance costs.

Economic and Social Well-Being

Stakeholders are concerned about local infrastructure maintenance including roads, timber mills, equipment, and skilled labor forces. Wildland fire, insect infestations, and forest diseases are other concerns related to forest health, which is linked to economic and social well-being. Also linked to forest health are concerns about the need for more restoration activities as they have the potential to create jobs and improve well-being.

The public expressed various ideas related to the importance of sustaining economic and social well-being through Forest Service land management. Community members value jobs and income in the local economy and maintaining traditions and social structures that maintain the social fabric. Opportunities to realize these values are what make the Blue Mountains Forest Plan Revision area vibrant and resilient. There are differing beliefs, however, about how forest planning should contribute to local social and economic well-being. Many commenters believe that supporting timber infrastructure through harvest, recreation, access, mining, and grazing are important to maintain local well-being, as it has been the backbone for their economy in the past. They believe that meeting local community and county goals for social and economic well-being is more important, or just as important, as the ecological goals of forest management.

Public comments revealed that people are concerned about retaining the social and economic benefits from forest lands in the area. One of the main issues is sustaining harvest and resulting jobs in the timber market. Some stakeholders believe that the Forest Service should provide a predictable flow of timber to support mills, loggers, truckers, as well as other local jobs, county government, and public services that contribute toward social and economics in the Plan Area. They believe that better support of logging and milling infrastructure helps retain the capacity needed to restore national forest lands and that the Forest Service should provide incentives to foster development of new forest-related industry and should support more mill competition.

Subsistence is a concern for many stakeholders in forest dependent communities. Commenters shared their belief that the Forest Service should include subsistence needs as an attribute of social well-being and community resilience. Such needs include access for firewood and fish and wildlife. They think that a more comprehensive list of services provided by the ecosystems should be included (for example as a table), which could be clearly linked to benefits for local residents.

Some stakeholders believe the Forest Service should not allow ecological considerations to override social and economic considerations. They say that social and economic issues should be a top priority and that the Forest Service should develop standards, guidelines and additional monitoring questions related to social and economic vitality. They also believe that social and economic values should be reflected in ecological goals and desired conditions. Stakeholders also

believe that the Forest Service should improve its working relationship with people to benefit the forest.

While some comments emphasized the social and economic values related to increasing resource extraction, other comments demonstrated a belief that the resource extraction on National Forest Systems lands incur long-term costs to the ecosystem, which could affect local social and economic well-being in the future. Commenters who believe extractive uses greatly support social and economic well-being in the community generally have positive attitudes towards actions that open the National Forest Systems lands for these uses. Commenters who believe extractive uses are incurring long-term costs to the ecosystem generally have positive attitudes towards restricting extractive uses. However, restoration activities can both benefit ecosystem health and produce timber. To a degree, both subsets of commenters could have positive attitudes towards restoration.

Livestock Grazing

Restrictions on grazing allotments, as well as potential income loss for ranchers are the focus of concerns. Ranchers are also concerned about the loss of ranching as a lifestyle. Others are concerned about negative impacts to fisheries, water quality, and biodiversity related to grazing in the Plan Area.

Grazing is another issue with social and economic concerns. Some stakeholders believe that the local economy and social structure will suffer from reduced grazing. On the other hand, there are competing values for the land currently used for grazing. Some people believe that the land is negatively impacted by grazing, including the ecological health of riparian areas, plant species, and wildlife. These commenters generally do not support grazing use.

Specifically, some commenters expressed the belief that grazing plays a key role in supporting the economies of local Blue Mountains communities and should not be reduced because of a “likely benefit” to aquatic species and their habitats, that grazing numbers could fall below those characterized in the Plan because the proposed plan would make grazing less viable.

Some stakeholders believe that the Forest Service should recognize the benefits of grazing including: the economic and social well-being of communities, weed control, fine fuels reduction, forage improvements, water improvements for wild ungulates, and potentially increased species richness. Some stakeholders believe that grazing is so closely tied to social and economic well-being that the Forest Service should include grazing under “Goal 2: Promote Social Well-being.”

Other stakeholders believe that the Forest Service should adopt forest plans that manage for reduced animal unit months (such as elimination, reduction of number by 75 percent, cutting the time allowed for grazing in half) and no livestock use in riparian areas, roadless areas, wilderness areas, reaches with listed fish, and seasonally-saturated meadows with fine-grained non-cohesive soils and no woody vegetation. These stakeholders say that this would help create healthy landscapes, restore fish and wildlife populations, protect water quality and soils, limit weed spread, restore sagebrush ecosystems, support recreation, and limit their impression of extensive and severe livestock damage. Comments were also made about noise and impacts to the wilderness experience associated with livestock grazing, especially as it relates to a hunting experience.

Some stakeholders value the ecological health of riparian systems more than livestock grazing. Some believe that the Forest Service should consider complete elimination or multi-year rest to recover damaged riparian systems. They believe the Forest Service should meet the requirements

of Executive Order 11990 to minimize the destruction, loss and degradation of wetlands by cattle and sheep and preserve and enhance the natural values of wetlands. Some stakeholders value sensitive plant species more than grazing. They say that the Forest Service should manage grazing to protect sensitive plant species and communities.

The Shoshone-Bannock Tribes value riparian and rare plant habitat. They believe that the Forest Service should develop a more comprehensive, representative monitoring strategy, including enforceable benchmarks that would trigger changes in grazing, and that the Forest Service should monitor allotments to ensure compliance with regulations.

Old Forests

Some stakeholders want to actively manage and restore old forests using mechanical treatments to improve resiliency to insects, diseases, and fires. Some want to restore old forest stands without the use of machines through the designation of old forest management areas. Commenters expressed a common value for old forests. The differences are related to beliefs about how old forests should be managed.

Stakeholders are concerned with the definition of old forest in the Forest Plan and environmental impact statement. Definitions are related to beliefs. Some say that the Forest Service should drop the 21-inch rule, which they view as arbitrary, and instead base management on what they consider sound science. These stakeholders believe that eliminating the 21-inch rule would help support roads, schools, and local services as well as local milling infrastructure and economic viability of projects. They believe that retaining all 21-inch trees results in the conversion of thousands of acres of ponderosa pine, larch, and dry forests to forests dominated by shade tolerant, fire intolerant species.

Other stakeholders believe the opposite regarding the 21-inch rule. They think that the Forest Service should retain the 21-inch rule and retain or increase old growth management areas to protect and increase old and large trees which are deficit on the landscape, help achieve the stated goal of increasing ecological resilience, and protect large snags. Retaining the 21-inch rule and old growth management areas, they believe would protect biodiversity and water quality; support nutrient cycling, carbon sequestration and other ecosystem functions; and conserve habitat for northern goshawk, pileated woodpecker, American marten, and other species. These commenters also believe protecting old forests would conserve natural heritage and regional cultural identity.

Other stakeholders say that the policy of retaining trees with old tree characteristics is too ambiguous. Instead, these stakeholders think that the Forest Service should provide more clarity on terms related to old forest management including old forest characteristics, old forest stands, and legacy trees.

Some commenters are concerned about pace and scale of restoration. These stakeholders believe that the Forest Service should create an alternative to increase the pace and scale of active management so that more of the national forest landscape is managed. Managing additional acres, they say, would better achieve desired conditions, such as reducing fire hazard and improving forest resistance to insects and diseases. In addition, they believe that managing additional acres would also better address the need for re-treatment in some areas to maintain desired stand densities and surface fuel levels. Some stakeholders believe that the Forest Service should increase the predicted annual timber harvest to capture a higher percentage of annual growth and thus reduce biomass accumulation and overstocked forest stands.

Other stakeholders value schools and collaborative efforts. They believe that the Forest Service should increase timber harvest to sustain harvesting and milling infrastructure, support current collaborative efforts and stewardship contracts, and fund schools. The timber program, they say, should provide a continuous supply of timber.

Increasing the allowable sale quantity to support current logging and milling infrastructure is viewed by some stakeholders as needed for social and economic well-being. Allowable sale quantity is even connected to trusting the Forest Service in the eyes of some stakeholders. They believe that the Forest Service should use what they consider realistic timber harvest numbers to help create more trust of forest leadership and employees.

While some stakeholders believe that more logging is needed in the Plan Area to support social and economic well-being, others think that the Forest Service should prohibit commercial logging in old growth stands, potential wilderness areas, roadless areas, riparian zones, and riparian habitat conservation areas.

Stakeholders who want lower timber harvests believe that the Forest Service should lower the allowable sale quantity to account for expected losses from wildfire, to store carbon, and support viability of species associated with dense forests and dead wood. In addition, they say that the Forest Service should acknowledge the small diameter of most trees currently on the landscape and the lack of commercial viability in harvesting such stands. They believe that the proposed pace of logging is ecologically unsustainable. These stakeholders believe ecological sustainability and timber production are largely incompatible.

Recommended Additions to the National Wilderness Preservation System

Some stakeholders want to add to more acres to the National Wilderness Preservation System. They value wilderness for its aesthetic qualities, recreational opportunities, and biodiversity. Others want fewer acres added to the Wilderness Preservation System because they believe that adding acres would limit timber production and decrease the Forest’s resiliency to insects, diseases, and fire. Some stakeholders believe that adding more acres to the Wilderness Preservation System negatively impacts the economy.

The stakeholders who say that the Forest Service should protect wildlands, including roadless areas and wild rivers, cite economic, social, and ecological concerns as the basis for their reasoning. Recreation opportunities are particularly important to these stakeholders. They believe in protecting wildlands, despite some potential income losses in local communities.

Members of the Capital Trails Vehicle Association, however, express different values and beliefs about wilderness. The Association says that the Forest Service should limit wilderness because it has negative economic impacts, in several ways: (1) minimizes the number of natural resource-related jobs (2) loss of income from motorized users, and (3) loss of county tax revenues. They say that an economic analysis for preliminary administratively recommended wilderness must be part of the environmental, economic and social well-being analysis.

Some stakeholders believe that recommending additional areas of wilderness will impede the plan's three goals: ecological integrity, social well-being, and economic well-being. They say that the Forest Service should not recommend 70,000 acres as suitable for inclusion in the National Wilderness Preservation System in the agency preferred Alternative E-Modified because, if designated by Congress, wilderness would restrict needed multiple-use activities, like mineral and timber extraction, and impede the plan's three goals.

Other comments received include:

- The Forest Service should not recommend wilderness areas throughout the three Blue Mountains national forests because it creates areas where there would be a lack of management, resulting in a decline in forest health through wildfire, insects and diseases, and noxious weeds.
- Adding more acres of wilderness harms local economies. "… the restriction of public land use will have an immense effect on local economies … more than $47.5 billion in spending on vehicles, parts, maintenance, insurance, registration, apparel and storage related to motorcycling and off-road riding. Not to mention fuel taxes." Along these lines, some say that the Forest Service should not recommend additional wilderness areas because they would have negative economic impacts since motorized users spend more than nonmotorized users.
- The Forest Service does not have sufficient funding and capacity to manage additional wilderness.
- The Forest Service should not recommend additional wilderness areas because these lands will be managed for wilderness characteristics, essentially creating de facto wilderness that only Congress should designate.
- The Forest Service should not recommend wilderness areas throughout the three Blue Mountains national forests because it emphasizes opportunities for wilderness recreationists and limits opportunities for motorized groups, including the elderly and handicapped.
- Some stakeholders are concerned about adding the land they currently use for grazing to designated wilderness areas, for fear they will lose their grazing use.

The beliefs described above mostly represent values of stakeholders who want fewer acres added to the National Wilderness Preservation System because they think that adding acres limits timber production and decreases the Forest's resiliency to insects, diseases, and fire. They believe that adding more acres to the National Wilderness Preservation System negatively impacts the economy.

The values expressed below are related to beliefs about the benefits of adding more acres to the National Wilderness Preservation System expressed by people who value wilderness for its aesthetic qualities, recreational opportunities, and biodiversity.

- The Forest Service should recommend more wilderness areas, especially in large blocks of intact habitat, in order to protect keystone species.
- The Forest Service should not limit the amount of recommended wilderness due to the capacity of existing wilderness because the quality of a wilderness area and its benefits to the ecosystem and citizens have more to do with the area than the numbers of people using the area.
- The Forest Service should recommend all wilderness-eligible lands, including all undeveloped roadless areas and potential wilderness areas in the backcountry, for wilderness designation.
- The Forest Service should protect recommended wilderness areas to heighten their conservation value. These commenters refer to recent motorized use studies showing the need to protect certain areas for historic and quiet recreation.

Ecological Resilience

Some stakeholders expressed a desire for more management activities designed to restore ecological resilience. They believe that restoring ecological resilience will also improve ecosystem services (interpreted as benefits the forests provide). Others want fewer management activities aimed at ecological resilience.

Some stakeholders strongly believe that Forest Service should not allow ecological considerations to override social and economic considerations, as they believe that social and economic issues should be a top priority. They also believe that the Forest Service should develop standards, guidelines and additional monitoring questions related to social and economic vitality, and that social and economic values should be reflected in ecological goals and desired conditions.

Along the same lines, some stakeholders believe that the Forest Service should prioritize economics over ecology, and the effects of forest plan revision on local residents and communities should be the primary decision-making criteria for selecting the chosen alternative.

Some stakeholders go further saying that the Forest Service should work to maintain social and economic conditions rather than just contribute to these values.

Economic Contributions of National Forests

Stakeholders expressed the belief that the Forest Service should increase the Plan’s focus on supporting social and economic well-being of local communities through grazing, logging, mining, and access for recreation and subsistence needs. Comments included that managing for economic outputs could support vibrant rural communities; i.e., logging supports local mill infrastructure and associated road building would promote access for hunting and recreation which in turn could provide community stability and possibly support high quality local jobs.

The following section addresses the economic contributions of recreation, livestock grazing, and forest product harvesting from the Blue Mountains national forests. It also describes the economic contributions of Forest Service operations (salary and non-salary expenditures) and payments to states and counties to support local economic activity.

Recreation

Visitors to the Blue Mountains national forests have the opportunity to participate in a variety of activities in developed and dispersed settings. These activities include hiking, camping, and driving for pleasure, as well as wildlife and fish use, such as hunting, fishing, and wildlife viewing. These recreation activities contribute to people’s economic and social well-being. A common theme across Eastern Oregon residents is an appreciation for public lands because of outdoor recreation activities. However, the local economy in the BMFPR remains reliant on a variety of public land resources. The varied uses of public lands, some of which are not compatible with others, are a source of conflict among local community members and non-local stakeholders. For example, cattle grazing and timber production are traditional sectors of the economy. Local residents have strong beliefs about the importance of these sectors. While revenue from recreation related activities is growing, some local community members believe that recreation is less important to the local economy.

The Forest Service collects survey data on recreation through the National Visitor Use Monitoring program to better understand the role of recreation in local communities. Data for the first survey were collected between 2000 and 2003. The second round of National Visitor Use Monitoring data were collected for the three National Forests in 2009. The third round of data were collected

for the three National Forests in 2014. Comparisons across sampling years are not accurate due to changes in the study protocols. Only round 3 results are presented in Table 41.

Table 41. Total national forest site visits 2014

National Forest	Number of Visits
Malheur	160,000
Umatilla	168,000
Wallowa-Whitman	246,000

Source: USDA Forest Service NVUM 2016

Recreation visitors spend money on goods and services in the local area such as shopping at convenience stores or purchasing gasoline, food, lodging, and outfitter guide fees. Non-local and overnight visitors tend to spend more than day visitors. The visits are divided into seven categories based on visitor spending patterns (Table 42).

Table 42. Recreation visitors by spending category (2014)

Type of Visit	Malheur	Umatilla	Wallowa-Whitman
Non-Local Day	1,139	35,520	27,898
Non-Local Overnight (on National Forests)	82,000	41,957	44,462
Non-Local Overnight (off National Forests)	5,949	7,737	21,680
Local Day	55,365	53,613	108,331
Local Overnight (on National Forests)	5,105	16,867	2,760
Local Overnight (off National Forests)	0	527	524
Non-primary	10,797	11,973	40,383

Source: USDA Forest Service NVUM 2016

There are two key differences in recreation visitor spending categories. The first difference relates to geography. Are the visitors from the local area or are visitors from outside the local area? Non-local visitors bring cash into the socio-economic impact zone. The second difference relates to duration of visit. Overnight visitors spend more money on food and lodging than day visitors. Some overnight visitors stay on the National Forests; some stay in hotels and motels on private land. The classifications are important because recreation expenditures and the economic contributions are different. Trip expenditures by local day visitors are much less than expenditures by non-local visitors staying overnight. Day use visitors do not require lodging and typically spend less on goods and services.

Recreation activities support jobs and labor income in the local economy in retail and service industries, and can also contribute to housing values if people move to the area for the recreation opportunities. Commenter notes included:

- People living in the rural areas depend on the natural resources as a way of life, and with the demise of logging, forest recreation is all that is left to sustain small communities.
- Hunting and recreation are essential for the economies of the rural communities within the Forest boundary.”
- Local economies…have reaped huge benefits from an emphasis on recreational uses, especially nonmotorized uses like back-country packing and skiing.

People in the Blue Mountains area value recreation use on national forest land and believe it contributes to their local economies. They generally have positive attitudes towards access and opportunities that allow a full-spectrum of recreational activities on the forests. In addition to economic benefits, people value recreation opportunities within the national forests and believe they enhance the quality of life and sense of place for nearby residents. These commenters also have positive attitudes towards access and a wide array of recreation opportunities. Table 43, through Table 46 display the economic contributions of local and non-local recreation and wildlife-related visitors to the Blue Mountains national forests. Visitation to each of the national forests contributes similar amounts of employment and labor income in their respective socio-economic impact zones. However, the types of recreation activities differ considerably. For instance, wildlife-related recreation (e.g., hunting and fishing) account for the majority of employment and labor income attributable to visitation to the Malheur National Forest, but a relatively small share of employment and labor income attributable to visitation to the Wallowa-Whitman National Forest.

Table 43. Economic contributions of non-local recreation visitors, annual average

Indicator	Malheur	Umatilla	Wallowa-Whitman
Jobs	5	20	40
Labor Income	$122,000	$541,000	$923,000

Table 44. Economic contributions of non-local wildlife recreation visitors, annual average

Indicator	Malheur	Umatilla	Wallowa-Whitman
Jobs	43	23	13
Labor Income	$1,148,000	$699,000	$322,000

Table 45. Economic contributions of local recreation visitors, annual average

Indicator	Malheur	Umatilla	Wallowa-Whitman
Jobs	2	7	12
Labor Income	$44,000	$236,000	$256,000

Table 46. Economic contributions of local wildlife recreation visitors, annual average

Indicator	Malheur	Umatilla	Wallowa-Whitman
Jobs	5	2	4
Labor Income	$125,000	$61,000	$87,000

Livestock Grazing

Grazing is another issue with significant social and economic aspects. Restrictions on grazing allotments and potential income loss for ranchers are the focus of concerns. Ranchers are also concerned about the loss of ranching as a lifestyle.

Some stakeholders believe that grazing plays a key role in supporting the economies of local Blue Mountains communities and should not be reduced to improve ecological conditions. Also, some believe grazing numbers could fall below those characterized in the Plan because the proposed Plan would make grazing less viable.

Some stakeholders value the ecological health of riparian systems more than livestock grazing. Some believe that the Forest Service should consider complete elimination or multi-year rest to recover damaged riparian systems.

Livestock grazing on the Blue Mountains national forests contributes to the local economy and supports a way of life for ranching families. In 2009, the counties in the Oregon portion of the plan revision area had about 40 percent of the total cattle inventory of the state (USDA National Agriculture Statistics Service). Grazing on National Forest System lands (Table 47) directly provided about three percent of the forage needs of the local cattle inventory. The total contribution of grazing on National Forest System lands is likely understated since it affords ranchers the opportunity to grow forage on other ranch lands for feed.

Livestock grazing can be measured in head months and animal unit months for permitted use and authorized use. One animal unit month is the amount of forage a 1,000 pound mature cow and a calf consume in a 30-day period, which is about 780 pounds of dry weight. A head month is a month's use and occupancy of range by one adult (including weaned) animal, except for sheep or goats. Five sheep or goats, weaned or adult, are considered equivalent to one cow.

Table 47. Livestock grazing permittees and animal unit months (AUMs), 2014-2016 Average

Indicator	Malheur	Umatilla	Wallowa-Whitman
Number of Permittees	88	41	96
Cattle (Authorized AUMs)	115,300	42,800	111,300
Horses and Burros (Authorized AUMs)	60	0	300
Sheep and Goats (Authorized AUMs)	4,800	5,600	4,500

Source: USDA Forest Service iWeb Grazing Reports 2017

Permitted animal unit months are measures of planned capacity and are the number of animal unit months that are specified by the grazing permit for the duration of the permit (FSM 2230.5). The permit is usually valid for 10 years (FSM 2231.03). Permitted animal unit months provides a comparable indicator for Forest Service and Bureau of Land Management grazing capacity. Authorized annual unit months is the amount of forage permittees pay for and are authorized to use in a given year. Authorized annual unit months indicate how much of the planned capacity will be used annually. It is this use amount which contributes to jobs and income. Between 2014 and 2016, authorized cattle use across all three National Forests was about 80 percent of permitted use. Sheep and goats authorized use is about 50 percent of permitted use. Sheep and goats make up about 5 percent of grazing use on the three National Forests.

The economic activity associated with Forest Service livestock grazing is based on the proportion of forage consumed by animals authorized to graze on Forest Service allotments to total annual forage needs in each socio-economic impact zone. The Forest Service contribution is identified as part of the total cattle and sheep inventory, marketing, and income data from the USDA National Agriculture Statistics Service. Average grazing data for 2014 through 2016 are displayed in Table 47. This data is then integrated into IMPLAN model to generate the direct, indirect and induced employment and labor income that are contributed by each national forest.

The jobs and labor income contributions associated with current livestock grazing on the three National Forests and their socio-economic impact zones are displayed in Table 48. The effects are based on the average authorized grazing for 2014 through 2016 (as displayed in Table 47) and the IMPLAN 2014 model year. The data include direct, indirect, and induced effects.

Table 48. Economic contributions of livestock grazing, 2014-2016 annual average

Indicator	Malheur	Umatilla	Wallowa-Whitman
Jobs	406	206	392
Labor Income	$7,462,000	$3,311,000	$7,212,000

Forest Products

The Blue Mountains national forests have a long history of providing timber and other forest products to address local community and national needs. Until recently, communities throughout the socio-economic impact zones had strong economic components related to the wood products industry. Increased environmental protection, a focus on sustaining and restoring a broader range of resources resulting in PACFISH, INFISH, and Eastside Screen protections, and changing mill technology have resulted in significant declines in the timber industry and in the businesses that support the timber industry.

Stakeholders have expressed the importance of maintaining local infrastructure including roads, mills, equipment, as well as retaining a skilled labor force. Stakeholders also expressed the belief that restoration activities create jobs and improve socio-economic well-being as they improve forest health.

Annual timber volume harvested from the three National Forests, excluding fuelwood, has declined dramatically since the last forest plans were prepared, from a high of 680 million board feet in 1989-90 to about 80 million board feet in recent years. Harvest on other ownerships also declined over the same period (Oregon Department of Forestry 2017). The recent three year average timber harvest by national forest is displayed in Table 49. Non-sawtimber includes pulpwood and biomass, such as clean chips. Fuelwood includes both personal and commercial use.

Table 49. Timber harvest volume in thousand board feet (MBF), 2014-2016 average by National Forest

Product	Malheur	Umatilla	Wallowa-Whitman
Sawtimber	20,451	12,955	10,815
Non-Sawtimber	6,283	5,299	3,910
Poles	105	78	146
Posts	9	<1	<1
Fuelwood	3,706	5,476	5,116
Total	37,149	23,808	19,988

Source: USDA Forest Service Cut and Sold Reports 2016

Between 1989 and 2008, wood products processing capacity declined dramatically in Oregon. Data for Washington and Idaho were not available. There was a decrease in sawmill production of almost 60 percent (Figure 17). Between 2008 and 2013, sawmill production increased modestly – by approximately 10 percent. Despite the increase in volume processed between 2008 and 2013, the number of forest product facilities in Oregon declined over this period – from 251 facilities in 2008 to 188 facilities in 2013 (Simmons et al. 2016). Processing capacity is important for several reasons. It generates value added jobs and income in addition to those jobs associated with logging. Local processing capacity increases the net value of stumpage since it costs more to ship

logs to distant mills. A higher stumpage value means projects are more likely to be economically viable.

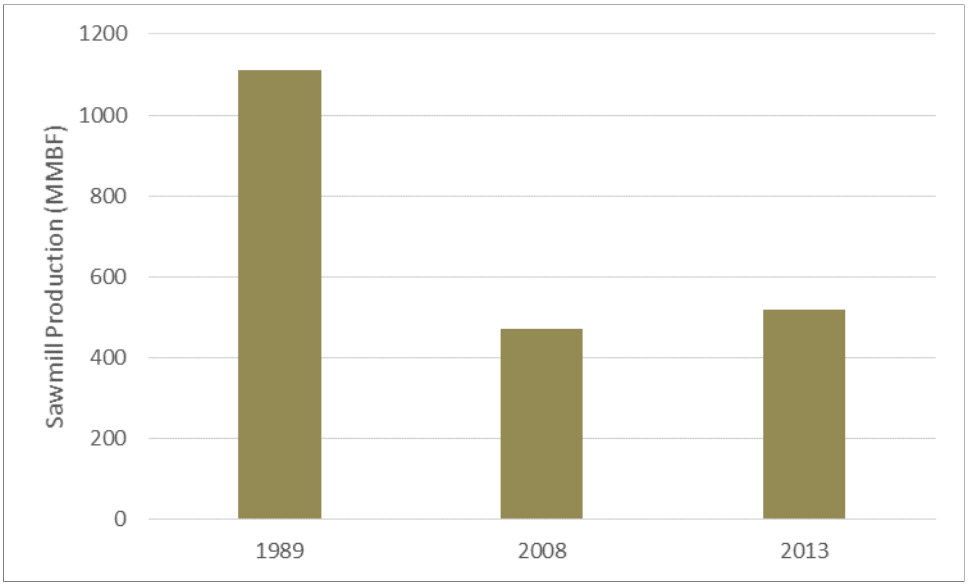


Figure 17. Sawmill production in Eastern Oregon
Source: Paul F. Ehinger and Associates 2008; Simmons et al. 2016

The economic activity associated with timber harvest is calculated on a per hundred cubic feet (CCF) basis. The flows of stumpage through logging companies and primary processors, such as sawmills, veneer and plywood mills, and paperboard manufactures, are considered.

The direct economic effect of the timber program is derived using mill survey data provided by Charles E. Keegan, Bureau of Business and Economic Research, The University of Montana. The direct job effect of timber harvest is determined by identifying the timber volume processed or handled by an industry, such as sawmills, and dividing the total employment for that industry by that number. The process derives a response coefficient for jobs per hundred cubic feet. The response coefficient is integrated with the IMPLAN models for each socio-economic impact zone to calculate the rest of the direct, indirect and induced employment and labor income contributions for the timber industries and supporting businesses that exist in each socio-economic impact zone. These contributions associated with the timber harvested from the three National Forests and their socio-economic impact zones are displayed in Table 50.

Table 50. Economic contributions of timber harvest, 2014-2016 annual average

Indicator	Malheur	Umatilla	Wallowa-Whitman
Jobs	163	137	115
Labor Income	$9,658,000	$8,258,000	$6,508,000

National Forest Expenditures

Within the Blue Mountains national forests, Forest Service operations and infrastructure contribute to social and economic well-being in the communities. The management of each of the national forests requires a budget that is spent on employees, contractors, goods and services, and the construction and maintenance of infrastructure. In addition to the day-to-day scheduled

management activities, the Forest Service sometimes spends additional money for unplanned activities, such as wildfire suppression and management. The expenditures for each national forest are reported over three fiscal years (Table 51).

Table 51. National Forest expenditures, fiscal year 2012-2014

Indicator	Malheur	Umatilla	Wallowa-Whitman
Fiscal Year 2012	$23,114,100	$22,401,800	$27,757,500
Fiscal Year 2013	$26,242,200	$19,796,000	$29,307,800
Fiscal Year 2014	$24,080,300	$20,345,000	$24,377,400
2012-2014 Average	$24,478,900	$20,847,600	$27,147,600

Forest Service employees spend their earnings in the socio-economic impact zones – on housing, food, and other goods and services. Forest Service expenditures on supplies, equipment, and contracts also contribute to economic activity in the local area. Therefore, Forest Service expenditures contribute to both public sector and private sector employment in the socio-economic impact zones. Table 52 displays the economic contributions of the Blue Mountains national forests' expenditures.

Table 52. Economic contribution of Forest Service expenditures, 2012-2014 average

Indicator	Malheur	Umatilla	Wallowa-Whitman
Jobs	500	420	577
Labor Income	$17,607,000	$19,136,000	$20,419,000

Revenue Sharing and Payments to Counties

Counties receive Federal payments based on revenue sharing under the Payments to States Act, also known as 25-percent receipts, and based on the percentage of their land base that is federally administered under the Payments in Lieu of Taxes program that is managed by the Department of Interior. Due to declining revenues, especially from timber receipts, the Payments to States Act money was supplemented with the Secure Rural Schools and Communities Self-Determination Act (herein referred to as the Secure Rural Schools).

The last payment under the original Secure Rural Schools was originally planned for 2006. Secure Rural Schools payments have subsequently been reauthorized several times. However, as of April 2017, Secure Rural Schools payments have not been reauthorized for fiscal year 2017 or beyond. Because the continuation of Secure Rural Schools payments are uncertain, the revenue sharing amount without the Secure Rural Schools adjustment is also provided.

Table 53 displays the amounts of Secure Rural Schools and Payments in Lieu of Taxes money paid in 2014 to the counties in each of the socio-economic impact zones. In 2014, Umatilla County did not choose the Secure Rural Schools payment and opted for the 25-percent receipts payment. This payment is included in the table below.

Since it is unknown whether the Secure Rural Schools payments will be continued into the future, an estimate of payments to states is provided in Table 54. The revenue sharing data are based on a rolling average of forest receipts received from 2007 to 2013. The data are used to reconstruct what the payments would have been without Secure Rural Schools. The payments estimated in

the table show a drop of 85 percent or greater from payments received under Secure Rural Schools.

Table 53. Total Forest Service payments from Secure Rural Schools (SRS) and Payment in Lieu of Taxes (PILT), 2014

Payment Type	Malheur	Umatilla	Wallowa-Whitman
SRS	$4,044,319	$1,761,961	$2,773,647
PILT	$511,054	$2,084,986	$1,692,164
Total	$4,555,373	$3,846,947	$4,465,811

Table 54. Reconstructed Forest Service 25-percent payments

Indicator	Malheur	Umatilla	Wallowa-Whitman
25 Percent (Reconstructed)	$174,330	$231,828	$202,573

Secure Rural Schools and Payments in Lieu of Taxes payments to counties are a component of local government revenue. In order to calculate the economic contribution of the payments, the money is applied to several sectors using the IMPLAN model. All of Payments in Lieu of Taxes is applied to the non-schools local government sector. The Secure Rural Schools payment is split four ways. About 60 percent is applied to highway construction and maintenance to capture the county roads portion of Title 1, 20 percent is applied to the schools sector of local government for the rest of Title 1, 10 percent is applied to ecosystem management projects on National Forest System lands for Title 2, and 10 percent is applied to the local government sector for Title 3.

The employment and labor income contributions are identified in Table 55. The contributions are based on the payments received by socio-economic impact zone and the IMPLAN 2014 model year. The data include direct, indirect, and induced contributions.

If Secure Rural Schools payments are not extended and are instead based on 25-percent revenue sharing payments, the jobs, income and tax impacts could be greatly reduced. Table 56 displays the estimated job, income and tax impacts of the estimated 25-percent payments reconstructed from 2007-2013 data and actual Payments in Lieu of Taxes payment data for 2014.

Table 55. Economic contribution of Forest Service payments to counties, annual average

Indicator	Malheur	Umatilla	Wallowa-Whitman
Jobs	42	44	55
Labor Income	$1,539,000	$2,006,000	$2,024,000

Table 56. Estimated Economic contribution of Forest Service payments to counties without SRS, annual average

Indicator	Malheur	Umatilla	Wallowa-Whitman
Jobs	8	28	25
Labor Income	$323,000	$1,335,000	$1,031,000

Economic Contributions Summary

Table 57 and Table 58 summarize the number of jobs and amount of labor income attributable to national forest management activities in each socio-economic impact zone. Additionally, the economic contributions of recreation, range, timber, agency expenditures, and payments to counties discussed previously are combined and displayed in a table for each national forest that displays the number of jobs in each economic sector (Table 59 through Table 61). The data for jobs and labor income contributed by the Forest Service are compared to the total jobs and labor income by industry sector to identify the relative importance of the national forest to that sector and to the socio-economic impact zone overall. Forest Service program areas do not correspond directly to economic sectors. For example, while many of the jobs associated with timber harvests and livestock grazing on national forests are in the agriculture sector, indirect employment effects occur in transportation and warehousing, among many other sectors.

Table 57. Summary of economic contributions by Forest Service program area, average annual number of jobs

Program Area	Malheur	Umatilla	Wallowa-Whitman
Recreation (non-local only)	48	43	53
Livestock Grazing	406	206	392
Forest Products	163	137	115
National Forest Expenditures	500	420	577
Payments to States and Counties	42	44	55
Total	1,159	850	1,192

Table 58. Summary of economic contributions by Forest Service program area, average annual labor income

Program Area	Malheur	Umatilla	Wallowa-Whitman
Recreation (non-local only)	$1,270,000	$1,240,000	$1,245,000
Livestock Grazing	$7,462,000	$3,311,000	$7,212,000
Forest Products	$9,658,000	$8,258,000	$6,508,000
National Forest Expenditures	$17,607,000	$19,136,000	$20,419,000
Payments to States and Counties	$1,539,000	$2,006,000	$2,024,000
Total	$37,535,000	$33,952,000	$37,409,000

The Forest Service economic relationship to the Malheur socio-economic impact zone shows strong economic ties with approximately 14 percent of employment and labor income attributable to activities on the Malheur National Forest (Table 59). Several industries with large numbers of jobs show contributions of 10 percent or more based on goods and services provided by the national forest and budget expenditures and payments to counties. The jobs and labor income supported through Forest Service management activities are very important components to the Malheur socio-economic impact zone's socio-economic well-being.

Table 59. Current contributions of the Forest Service to the Malheur socio-economic impact zone, annual average

Contribution	Total Area Employment	FS-Related Employment	Total Area Labor Income (Thousands)	FS-Related Labor Income (Thousands)
Agriculture	1,657	444	$34,538	$11,423
Mining	48	1	$738	$19
Utilities	22	1	$2,724	$106
Construction	387	14	$13,930	$551
Manufacturing	101	37	$4,797	$2,125
Wholesale Trade	123	15	$3,138	$570
Transportation & Warehousing	762	10	$17,201	$422
Retail Trade	130	61	$2,316	$1,648
Information	94	4	$3,253	$187
Finance & Insurance	423	19	$5,752	$479
Real Estate & Rental & Leasing	190	10	$939	$69
Prof, Scientific, & Tech Services	260	47	$9,487	$917
Mgt. of Companies	4	0	$389	$41
Admin, Waste Mgt. & Rem Serv.	182	9	$5,114	$281
Educational Services	65	3	$740	$48
Health Care & Social Assistance	719	28	$18,080	$884
Arts, Entertainment, and Rec	215	7	$875	$69
Accommodation & Food Services	410	34	$8,574	$816
Other Services	484	25	$9,471	$665
Government	1,806	390	$119,310	$16,216
Total	8,080	1,159	$261,365	$37,535
Forest Service as Percent of Total	Not applicable	14.30%	Not applicable	14.36%

The Forest Service contributes about one-half of 1 percent to total employment and labor income in the Umatilla socio-economic impact zone. The contributions by industry sector are also generally less than 1 percent (Table 60). The jobs and labor income supported through Forest Service management activities, though less important to socio-economic impact zone's economy overall, are important to the socio-economic well-being of some individual businesses, workers, and families.

Table 60. Current contribution of the Forest Service to the Umatilla socio-economic impact zone, annual average

Contribution	Total Area Employment	Forest Service-Related Employment	Total Area Labor Income (Thousands)	Forest Service-Related Labor Income (Thousands)
Agriculture	16,330	215	$539,919	$4,989
Mining	369	0	$7,785	$5
Utilities	699	1	$102,140	$171
Construction	6,237	8	$258,582	$364
Manufacturing	15,995	44	$904,736	$2,726
Wholesale Trade	3,132	10	$166,874	$581
Transportation & Warehousing	13,888	17	$385,500	$843
Retail Trade	6,733	52	$320,885	$1,507
Information	1,586	4	$68,925	$183
Finance & Insurance	4,913	12	$205,717	$560
Real Estate & Rental & Leasing	3,965	15	$54,778	$177
Prof, Scientific, & Tech Services	5,105	25	$223,488	$818
Mgt. of Companies	306	1	$20,599	$51
Admin, Waste Mgt. & Rem Serv.	3,995	11	$150,519	$338
Educational Services	1,908	4	$65,523	$149
Health Care & Social Assistance	17,039	44	$797,861	$2,247
Arts, Entertainment, and Rec	2,305	9	$26,846	$126
Accommodation & Food Services	8,903	42	$179,591	$858
Other Services	6,804	21	$249,052	$898
Government	23,862	313	$1,455,851	$16,359
Total	144,074	850	$6,185,173	$33,952
Forest Service as Percent of Total	Not applicable	0.59%	Not applicable	0.55%

The Forest Service economic relationship to the Wallowa-Whitman socio-economic impact zone shows moderate economic ties to employment and labor income (approximately 4 percent contributions; Table 61). The jobs and income supported through Forest Service management activities are moderately important components to the Wallowa-Whitman socio-economic impact zone's socio-economic well-being.

Table 61. Current contributions of the Forest Service to the Wallowa-Whitman socio-economic impact zone, annual average

Contribution	Total Area Employment	FS-Related Employment	Total Area Labor Income (Thousands)	FS-Related Labor Income (Thousands)
Agriculture	3,271	382	$56,768	$6,953
Mining	439	1	$7,816	$12
Utilities	162	2	$15,604	$217
Construction	1,371	13	$41,248	$428
Manufacturing	2,200	37	$106,066	$2,184
Wholesale Trade	490	11	$21,653	$720
Transportation & Warehousing	3,134	24	$74,848	$951
Retail Trade	1,617	63	$52,750	$1,688
Information	252	4	$10,067	$182
Finance & Insurance	850	12	$25,569	$484
Real Estate & Rental & Leasing	1,000	23	$8,670	$207
Prof, Scientific, & Tech Services	1,078	57	$35,927	$1,338
Mgt. of Companies	83	1	$6,239	$120
Admin, Waste Mgt. & Rem Serv.	721	12	$14,352	$261
Educational Services	121	2	$2,387	$43
Health Care & Social Assistance	2,954	36	$125,515	$1,908
Arts, Entertainment, and Rec	478	10	$4,245	$113
Accommodation & Food Services	1,726	49	$32,304	$1,011
Other Services	1,800	23	$49,080	$833
Government	3,789	433	$225,434	$17,755
Total	27,536	1,192	$916,544	$37,409
Forest Service as Percent of Total	Not applicable	4.33%	Not applicable	4.08%

Economic and Social Well-being – Environmental Consequences

The following discussion describes the potential direct, indirect, and cumulative effects on social and economic well-being for each alternative. The evaluation of effects focuses on the economic contribution of the alternatives on local economies; the effect of changes in management activities on goods and services; and the resulting impacts on users and their values. The indicators include predicted volume of timber planned for sale (TSPQ), grazing use, and employment and income contributions. The employment and income contributions are measured for recreation, range, timber, agency expenditures, and revenue sharing and payments to counties. Impacts to non-use and non-market values are also discussed.

The budget needed to implement each alternative is different. The environmental consequences analysis assumes that the agency has the budget needed to fully implement each alternative. However, since Forest Service budgets are based on annual appropriations from Congress, the actual funding available to implement management actions on the Blue Mountains national forests is uncertain. The budget assumptions are discussed in more detail in the "National Forest Expenditures" section below.

Social and Economic Well-Being Indicators

This analysis addresses how each alternative could affect social and economic well-being in the socio-economic impact zones. Table 62 lists the resource indicators and measures used to compare the effects of each of the eight alternatives under consideration.

Table 62. Social and economic well-being indicators

Resource Indicator	Measure(s)
Livelihoods	Number of jobs and amount of labor income associated with national forest resources and uses
Opportunities to use and enjoy national forest resources	Estimated cattle and sheep AUMs, predicted volume of timber planned for sale (TSPQ), proportion of forests open to motorized and nonmotorized uses, acres of preliminary administratively recommended wilderness
Environmental justice	Qualitative analysis of the potential for Forest Service management actions to disproportionately and adversely affect low-income and minority populations

Recreation

For all alternatives, the quantity of recreation visits to the national forests is not expected to vary from current use levels. The current supply of recreational opportunities is expected to exceed demand for the foreseeable future. Therefore there is no estimated change to the overall level of national forest recreation visitor spending, so no change is estimated for jobs and labor income supported by visitor spending (Table 63 and Table 64). It is possible that use patterns may change within a socio-economic impact zone due to changes in access and use patterns, causing localized economic impacts. However, that scale is not addressed in this forest wide evaluation nor are such localized effects foreseeable given available information.

The economic impacts of non-local recreation visitation are summarized in the tables below. As described in the "Economic and Social Well-being – Affected Environment" section, non-local visitors bring "new money" to the socio-economic impact zones. Their expenditures support jobs and income that would not likely exist in the absence of recreation opportunities that attract tourists.

Table 63. Estimated jobs supported by non-local recreation on national forests, by alternative, annual average

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	48	48	48	48	48	48	48	48
Umatilla	43	43	43	43	43	43	43	43
Wallowa-Whitman	53	53	53	53	53	53	53	53

Table 64. Estimated labor income (thousands, 2014 USD) supported by non-local recreation on national forests, by alternative, annual average

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	$1,270	$1,270	$1,270	$1,270	$1,270	$1,270	$1,270	$1,270
Umatilla	$1,240	$1,240	$1,240	$1,240	$1,240	$1,240	$1,240	$1,240
Wallowa-Whitman	$1,245	$1,245	$1,245	$1,245	$1,245	$1,245	$1,245	$1,245

The alternatives vary for the amount of backcountry nonmotorized acres and recommended wilderness areas, from no preliminary administratively recommended wilderness areas under Alternatives A and D to more than half a million acres across the three National Forests under Alternative C. Table 65 displays the number of backcountry nonmotorized acres by national forest and by alternative and Table 66 displays the preliminary administratively recommended wilderness areas by national forest and by alternative. Wilderness and other nonmotorized areas benefit individuals who prefer to recreate in quiet settings. Due to differences in size and speed, motorized and nonmotorized recreation can lead to user conflict. Alternative C, therefore, would provide the most opportunities to individuals who prefer nonmotorized recreation opportunities in the backcountry. In contrast, Alternative C may adversely affect access for motorized recreational users. Alternatives A and D would provide the most benefits to people who value motorized access and motorized recreational opportunities and may adversely affect those seeking nonmotorized recreational opportunities on the three National Forests.

Table 65. Backcountry nonmotorized use (acres)

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	0	59,300	270,400	0	53,600	47,200	47,200	53,600
Umatilla	0	19,300	105,800	0	70,100	49,700	49,700	70,100
Wallowa-Whitman	0	0	210,000	0	104,400	31,700	31,700	104,400

Table 66. Preliminary administratively recommended wilderness areas (acres)

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	0	1,200	83,800	0	30,400	26,600	26,600	30,400
Umatilla	0	1,400	248,500	0	40,100	31,900	31,900	40,100
Wallowa-Whitman	0	10,800	172,700	0	20,300	12,000	12,000	20,300

The three National Forests currently manage nearly one million acres of designated wilderness areas. The National Visitor Use Monitoring survey estimates that approximately nine percent of visits to the Malheur National Forest, three percent of visits to the Umatilla National Forest, and seven percent of visits to the Wallowa-Whitman National Forest are to a designated wilderness area (USDA Forest Service 2016a, 2016b, 2016c). According to the National Visitor Use Monitoring surveys for each of the three National Forests, few visitors to designated wilderness areas report that the areas are crowded (USDA Forest Service 2016a, 2016b, 2016c). Visitors to the Malheur National Forest were most likely to report that designated wilderness was at least

moderately crowded, with 14 percent of respondents rating designated wilderness as a seven or higher on a scale of 1 to 10 (10 indicates an area is overcrowded). The Malheur National Forest also has the fewest acres of designated wilderness – about 82,000 acres – among the three National Forests. These findings suggest that there is variation across the three National Forests, but that overall current designated wilderness areas are satisfying recreational demand.

The social value of designated wilderness is not limited to recreation. Wilderness designation may provide amenity values to nearby residents and landowners, support ecosystem service provision (e.g., clean water and carbon sequestration), and offer opportunities for research and environmental education. Designated wilderness may protect "non-use" values. Non-use values arise not from the consumption of goods or services provided by wilderness areas, but from the value of knowing it exists or preserving the option to visit in the future. However, designated wilderness can also limit opportunities to use national forests to support livelihoods (e.g., through timber harvesting) and to implement actions to promote forest resilience to insects, disease, and fire (e.g., through restoration treatments such as mechanical thinning and prescribed burning).

Livestock Grazing

Estimates of permitted cattle and sheep grazing are used to generate the economic effects of the alternatives. Permitted grazing use rather than authorized use is evaluated because it represents the strategic intent of the alternatives. Actual use will depend on forage availability and market conditions. The economic effects included here may be overestimated by up to 20 percent.

The projected amounts of permitted cattle grazing are displayed in Table 67. The amount of cattle grazing within each national forest would be similar for Alternatives A, B, D, E, and F. Alternative C would provide the least amount of forage available to cattle on each national forest. Permitted cattle Animal Unit Months would be cut by approximately half on the Malheur National Forest, 90 percent on the Umatilla National Forest, and two-thirds on the Wallowa-Whitman National Forest. In contrast, Alternative E-Modified and E-Modified Departure would support the highest levels of cattle grazing on National Forest System lands in the socio-economic impact zones. The E-Modified alternatives show higher AUMs due to the inclusion of vacant allotments in these estimates.

Table 67. Estimated cattle permitted animal unit months (AUMs) by alternative

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	117,000	120,000	61,000	119,000	117,000	126,000	126,000	117,000
Umatilla	30,000	31,000	3,000	30,000	30,000	39,000	39,000	30,000
Wallowa-Whitman	77,000	74,000	26,000	80,000	77,000	107,500	107,500	77,000
TOTAL	224,000	225,000	90,000	229,000	224,000	272,500	272,500	224,000

The amount of forage available for sheep would vary across the alternatives for each national forest. As with cattle grazing, Alternative C would provide the fewest opportunities to graze sheep on National Forest System lands in the socio-economic impact zones and Alternatives E-Modified and E-Modified Departure would provide the most opportunities.

Table 68. Estimated sheep permitted animal unit months (AUMs) by alternative

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	6,500	6,500	1,200	6,500	6,500	7,200	7,200	6,500
Umatilla	7,800	4,600	1,200	5,800	5,800	10,200	10,200	5,800
Wallowa-Whitman	4,500	3,500	3,500	4,500	3,500	4,500	4,500	3,500

The total of direct, indirect, and induced jobs and labor income supported by permitted cattle and sheep grazing are displayed in Table 69 and Table 70 and are sorted by national forest and by Alternative. The results are consistent with the alternative estimates of permitted forage. Both Modified E Alternatives would support the most jobs and labor income and Alternative C would support the least. The rest of the alternatives would support approximately equal amounts of jobs and income compared to Alternative A.

Table 69. Estimated jobs supported by livestock grazing on national forests by alternative, annual average

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	426	435	204	432	426	460	460	426
Umatilla	187	155	23	165	165	244	244	165
Wallowa-Whitman	282	264	112	292	274	379	379	274

Table 70. Estimated labor income (thousands, 2014 USD) supported by livestock grazing on national forests by alternative, annual average

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	$7,690	$7,875	$3,851	$7,814	$7,690	$8,296	$8,296	$7,690
Umatilla	$2,653	$2,445	$301	$2,481	$2,481	$3,453	$3,453	$2,481
Wallowa-Whitman	$5,077	$4,820	$1,858	$5,262	$5,005	$6,959	$6,959	$5,005

Livestock grazing has both social and economic dimensions. Ranching provides an income for some individuals, but it also has sociocultural value. In the West, ranching cannot be entirely understood through a commercial agriculture, economic impact lens. Indeed, in the western United States, most ranchers have an off-ranch job. Ranching provides noneconomic benefits, such as support for tradition and heritage (Smith and Martin 1972, Raish and McSweeney 2003).

Over the past 20 years, academic literature has addressed the shift from the “Old West” – a rural economy based on extractive natural resources – to the “New West, which is characterized by tourism development and amenity migration (Winkler et al. 2007). This change has contributed to economic diversification (discussed in a subsequent section), but has also led to cultural conflict (Ooi et al. 2015).

Ranch ownership can strengthen ties to the community, fellow ranchers, and families. Research has found that many ranchers identify the value of ranching as being closer to the earth, providing a desirable place to raise a family, and providing a satisfying way of life (Smith and Martin

1972). Interaction with other ranchers builds networks and social capital (Ooi et al. 2015). Such interpersonal relationships contribute to a sense of belonging and quality of life.

The maintenance of ranches in the socio-economic impact zones contributes to the preservation of open space. Without access to allotments on the Forest, some ranches may no longer be economically viable. The sale of ranches often leads to conversion of ranchland to sub-divided developments that reduce the availability of open space (Brunson and Huntsinger 2008).

Alternative C would do the least to support ranch viability in the socio-economic impact zones. In addition to effects on employment and labor income, this alternative could affect culture, tradition, and quality of life. All other alternatives would continue to support similar levels of livestock grazing on the forests as current conditions.

Forest Products

The predicted levels of timber volume sold are used to estimate the amount of economic activity for each alternative. The timber volume amounts are mostly comprised of sawtimber and non-sawtimber, such as pulpwood and biomass and fuelwood (Table 71 through Table 73). Smaller amounts of posts and poles, which are harvested mostly for personal use, are also included. The posts, poles, and fuelwood amounts are not predicted to vary by alternative.

A timber production emphasis focuses more on the production of saw logs. Alternative D, with an emphasis on high levels of sawtimber production, would have the greatest timber production level. The proportion of sawtimber harvest compared to total harvest would also be greatest in Alternative D. Conversely, Alternative C, has a decreased emphasis on timber harvest. The emphasis on timber production differs across alternatives, therefore the total amount of harvest, sawtimber, and non-sawtimber would vary.

Table 71. Estimated annual Malheur National Forest timber volume sold (MBF) by alternative

Timber Product	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Sawtimber	29,200	42,600	14,700	134,500	78,800	79,200	125,300	55,100
Non-sawtimber	2,800	2,400	1,300	6,500	4,200	4,800	8,700	2,900
Fuelwood	4,357	4,357	4,357	4,357	4,357	4,357	4,357	4,357
Other	134	134	134	134	134	134	134	134
Total	36,491	49,491	20,491	145,491	87,491	88,491	138,491	62,491

Table 72. Estimated annual Umatilla National Forest timber volume sold (MBF) by alternative

Timber Product	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Sawtimber	25,600	36,000	13,100	105,300	55,500	54,300	90,600	45,800
Non-sawtimber	1,300	1,000	500	2,700	1,500	1,700	3,400	1,200
Fuelwood	4,976	4,976	4,976	4,976	4,976	4,976	4,976	4,976
Other	141	141	141	141	141	141	141	141
Total	32,017	42,117	18,717	113,117	62,117	61,117	99,117	52,117

Table 73. Estimated annual Wallowa-Whitman National Forest timber volume sold (MBF) by alternative

Timber Product	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Sawtimber	18,400	28,200	10,200	99,800	60,700	62,200	92,000	39,400
Non-sawtimber	1,500	1,300	600	4,000	2,500	2,600	6,000	1,600
Fuelwood	6,608	6,608	6,608	6,608	6,608	6,608	6,608	6,608
Other	242	242	242	242	242	242	242	242
Total	26,750	36,350	17,650	110,650	70,050	71,650	104,850	47,850

Employment and labor income by alternative is based on the harvest level by product type displayed in above. The estimated timber related economic effects are displayed in Table 74 and Table 75. The timber production emphasis of Alternative D would support more than four times the level of employment of Alternative A on the Malheur and Umatilla National Forests and five times the level of employment of Alternative A on the Wallowa-Whitman National Forest. Timber harvest related employment under Alternative C would be about one-half of the level for Alternative A across all three National Forests. The rest of the alternatives compared to Alternative A and ranked in declining order are Alternatives E-Modified Departure, E-Modified, E, F, and B for all three National Forests.

Table 74. Estimated employment supported by timber harvest by alternative, annual average

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	170	243	86	761	447	451	717	313
Umatilla	253	352	129	1,026	542	531	887	447
Wallowa-Whitman	185	279	103	978	596	611	910	388

Table 75. Estimated labor income (thousands, 2014 USD) supported by timber harvest by alternative, annual average

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	$9,932	$14,114	$5,003	$44,226	$26,014	$26,267	$41,756	$18,198
Umatilla	$14,723	$20,453	$7,519	$59,647	$31,488	$30,871	$51,622	$25,985
Wallowa-Whitman	$10,308	$15,526	$5,708	$54,560	$33,238	$34,066	$50,812	$21,605

The full implementation of Alternative E-Modified Departure would generate substantial local employment and labor income effects during the first 20 years, when there would be increased timber volume sold. In that period, there would be approximately 2,500 jobs and $145 million in labor income attributable to timber harvests across the three National Forests. These 2,500 loggers and other workers in firms that do business with the forest products industry including restaurants and retails shops would need housing, schools, municipal services like trash collection and policing for themselves and their families. This could lead to declines in housing availability and affordability. For example, new residents and even long-time residents who rent and work in low wage sectors may have trouble finding affordable housing. Public services including

policing, schools, hospitals and roads could be overwhelmed during the boom. That means classrooms could be overcrowded and medical care could be difficult to obtain.

The substantial decline in timber volume sold at the end of the 20-year period could lead to decrease in incomes per capita in the communities surrounding all three National Forests in the socio-economic impact zones, increases in poverty, increases in unemployment compensation payments, foreclosures, personal and business bankruptcies, and decreases in tax revenue relative to what they would have been under the alternatives with a non-declining flow of timber volume sold.

In recent years, the Forest Service has been making more efforts to contribute to community stability and community resiliency. Alternative E-Modified Departure could have the greatest impact on the Malheur's community stability given the low population density and the high percentage of jobs related to timber harvest in the departure alternative. Especially on the Malheur, this alternative could lead to a boom-bust cycle that compromises community resiliency in the long term.

However, the ability of the Forest Service to implement the alternatives are contingent on budget allocations and sufficient demand for forest products. National forest budgets are not plan decisions. The federal appropriations process will determine the funding available to national forests to implement plan objectives. National Forest System budgets declined between fiscal years 2012 and 2016 (Hoover 2016). Meanwhile, an increasing share of the Forest Service's budget is spent on wildland firefighting (WFLC 2010).

National Forest Expenditures

The national forest budgets are made up of salary and non-salary expenditures. Non-salary expenditures are the purchases of goods and services, including contracting for restoration activities, and are for acquiring and maintaining facilities and other infrastructure. As discussed above, the national forests' budgets are not affected by the forest plan. However, full implementation of each alternative is expected to require different expenditures. Table 76 displays the budget required for full implementation of each alternative. On all three National Forests, Alternatives A and B would be consistent with current expenditures, Alternative C would have the lowest budget requirements, and Alternatives D, E (including Alternative E-Modified and E-Modified Departure), and F would require budget increases of several million dollars per year to fully implement management activities. The increased timber volumes under each of these alternatives would drive the need for additional agency expenditures (e.g., growth or reduction in agency employment).

Table 76. Estimated budget required for full implementation of each alternative (thousands, 2014 dollars)

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	$24,479	$24,479	$22,296	$29,949	$26,968	$26,968	$26,968	$25,176
Umatilla	$20,848	$20,848	$20,079	$24,913	$23,240	$23,240	$23,240	$21,606
Wallowa-Whitman	$27,148	$27,148	$25,885	$28,400	$28,256	$28,256	$28,256	$27,248

Since the selection of an alternative will not determine future budget allocations, this section does not estimate the economic impacts of changes in Forest Service expenditures.

Revenue Sharing and Payments to Counties

Like national forest expenditures, payments to states and counties are not forest plan decisions. Payments in lieu of taxes (PILT) and Secure Rural Schools (SRS) payment formulas are set nationally. The economic contribution of Forest Service payments to counties in the socio-economic impact zones are detailed in Table 61 and Table 56. However, as mentioned above, as of April 2017 the Secure Rural Schools program has not been reauthorized. Without reauthorization, counties receive 25 percent revenue sharing payments. These payments would be affected by activities implemented on national forests in the socio-economic impact zone. Higher timber harvest volumes under Alternatives D, E (including the Alternative E-Modified and E-Modified Departure), and F could increase revenue sharing payments to counties. However, the revenue associated with these alternatives is unknown in advance of timber sales. Therefore, potential variation in 25 percent payments cannot be calculated.

Ecological Integrity

Ecological integrity provides a variety of benefits to humans, including clean air and water, resilience to wildfire, carbon sequestration, and the resulting impacts to habitat for fish and wildlife. The effects of the alternatives on ecological integrity are addressed in detail in other sections of this Final Environmental Impact Statement. This analysis, therefore, briefly connects effects to ecological integrity with human well-being. The departure index measures the degree to which a landscape differs from its range of historical conditions. Dry forests were historically characterized by frequent, low-severity fires. Fire exclusion and suppression, therefore, has led to the greatest amount of departure in dry forests. The departure index is a proxy for forest resilience and sustainability. A lower departure index indicates greater resilience. Resilient forests provide a number of benefits to humans, including reduced risk of high-severity wildland fire, recreational opportunities associated with wildlife habitat (e.g., hunting or wildlife viewing), and water quality and quantity. The results assume that each alternative is fully implemented. Table 77 through Table 79 display the departure index by vegetation type and national forest. The estimation of the departure index is described in detail in the Ecological Resilience (Issue 6) section of this document.

Table 77. Departure index by vegetation type, year 20, Malheur National Forest

Vegetation Type	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Cold Forest	23	27	23	23	22	21	21	23
Dry Forest	56	54	56	47	51	51	49	53
Moist Forest	21	21	21	19	20	16	15	20

Table 78. Departure index by vegetation type, year 20, Umatilla National Forest

Vegetation Type	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Cold Forest	12	12	11	18	14	11	11	14
Dry Forest	57	55	57	49	53	52	51	54
Moist Forest	18	17	17	15	13	14	12	14

Table 79. Departure index by vegetation type, year 20, Wallowa-Whitman National Forest

Vegetation Type	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Cold Forest	25	24	24	26	26	23	23	25
Dry Forest	58	56	57	50	52	52	51	54
Moist Forest	24	23	23	21	22	22	21	22

Historic conditions are expected to provide high levels of naturally occurring biological diversity, and to provide the highest levels of functional and healthy ecosystems. On the Malheur National Forest, Alternative E-Modified Departure would support the most movement toward cold forest and moist forest resilience. Alternative D would support the most movement toward dry forest resilience. On the Umatilla National Forest, Alternatives C, E-Modified, and E-Modified Departure would support the most movement toward cold forest resilience. Alternative D would support the most movement toward dry forest resilience. Alternative E-Modified Departure would support the most movement toward moist forest resilience. On the Wallowa-Whitman National Forest, Alternative E-Modified Departure would support the most movement toward cold forest and moist forest resilience. Alternative D would support the most movement toward dry forest resilience.

Environmental Justice

All three socio-economic impact zones contain counties that include environmental justice populations. In particular, a number of the counties have high rates of poverty. Therefore, national forest management decisions that affect employment, income, or the cost of participating in activities on the national forests may disproportionately affect low-income populations. Only Alternative C is expected to reduce employment and labor income relative to current management (see Table 80). Opportunities for grazing livestock and harvesting forest products on the national forests would decline by about half under Alternative C. People who work in these, or associated sectors (e.g., forest product manufacturing), could be particularly adversely affected.

Additionally, Alternative C could increase the cost of accessing the national forests, due to large increases in preliminary administratively recommended wilderness areas (see Table 66) and fewer acres suitable for motor vehicle use (see Table 65). Increased costs of national forest access – in terms of fuel and time – may disproportionately affect low-income individuals. Therefore, Alternative C would have the potential to disproportionately and adversely affect environmental justice populations across all three socio-economic impact zones. Alternative E-Modified Departure would manage for a declining flow of timber volume sold from the Blue Mountains national forests. As described above, the declining flow of timber could lead to a boom-and-bust cycle. Low-income populations could be disproportionately affected by an economic boom and bust. While timber volume sold is elevated, in-migration could cause home prices to increase, which would disproportionately affect low-income individuals. However, low-income individuals may also benefit from increased employment opportunities. Under Alternative E-Modified Departure, the decline in timber volume sold after 20 years could lead to an economic bust. Low-income individuals would have fewer resources (e.g., savings and other assets) available to help them adapt to economic change.

Cumulative Effects

The Bureau of Land Management's John Day Basin Field Office recently revised their resource management plan. The John Day Basin Field Office manages public lands near the Blue Mountains national forests. The new plan closed and limited more acres of the field office to off-highway vehicle use and maintains fewer miles of open routes relative to the prior plan. The reduction in motorized opportunities on nearby public lands can affect off-highway vehicle use on the Blue Mountains national forests. Alternative C in the Blue Mountains Plan Revision Final Environmental Impact Statement would likewise limit motorized opportunities. The adoption of motorized use restrictions across multiple, adjacent public land areas can increase the costs of motorized recreation beyond what would occur if any single public land area reduced motorized opportunities. Motorized recreation users may have to travel farther and face higher costs due to reduced access across multiple jurisdictions. If users are unable to access their preferred sites, the quality of their experience would also be adversely affected.

The Bureau of Land Management's Oregon Sub-regional Greater Sage-Grouse Resource Management Plan Amendment incorporates Greater Sage-Grouse conservation measures across BLM-managed public lands in eastern Oregon. This plan amendment affects Baker, Grant, Harney, and Union counties, which include areas of all three Blue Mountains national forests socio-economic impact zones. Greater Sage-Grouse conservation measures may limit opportunities to use and enjoy public land resources, such as motorized recreation, livestock grazing, rights-of-way, and mineral extraction. Restrictions on public land resources and uses in Greater Sage-Grouse habitat may increase the demand for resources uses outside of Greater Sage-Grouse habitat. The Blue Mountains national forests Revised Plan also incorporates Greater Sage-Grouse direction. Therefore, Forest Service management actions may interact with the Oregon Sub-regional Greater Sage-Grouse resource management plan amendment to cause cumulative effects to natural resource-related employment and labor income and opportunities to access public land resources.

Climate change is expected to cause higher temperatures, decreased snowpack, earlier snowmelt, and increased vulnerability to disturbance (Halofsky and Peterson 2017). The ecological and socioeconomic systems in the Blue Mountains area are vulnerable to the effects of climate change. Municipal water supply, recreation opportunities, forage for livestock, and forest product availability may be reduced due to climate change (Halofsky and Peterson 2017). Climate change is expected to interact with Blue Mountains National Forest management decisions to affect resource quality and availability. The estimates of employment and labor income associated with livestock grazing on the Blue Mountains national forests assumes an adequate supply of forage. If climate change reduces forage availability, the employment and labor income estimates above (see Table 69) would be overestimated.

Drought and disease are expected to increase the intensity and extent of wildfire (Halofsky and Peterson 2017). Fires adjacent to communities in the Blue Mountains socio-economic impact zones may adversely affect private property and human health. Climate change would exacerbate these threats and reduce well-being in communities near the forests. Wildfire may also affect the supply of goods and services from the Blue Mountains national forests. For example, wildfire is expected to displace outdoor recreation users and may reduce associated employment and labor income (see Table 63 and Table 64). Wildfire may also affect quality and quantity of forest products available for harvesting on National Forest System lands, which would affect employment and labor income in logging, manufacturing, and related sectors (see Table 74 and Table 75).

In addition to the effects of climate change on National Forest System lands in the Plan Area, disturbances on adjacent lands, such as disease and insects, may affect the health of the Blue Mountains national forests. For example, invasive vegetation on adjacent lands may spread to the national forests or vice versa. Federal actions to improve forest resilience would support the provision of ecosystem services on both the Blue Mountains national forests and adjacent lands. The cumulative effect of disturbances across jurisdictions may affect community resilience and well-being, as the availability of substitute opportunities changes. Partnerships with adjacent landowners to achieve common goals related to ecosystem integrity may contribute to forest health across jurisdictions.

Summary of Results

Livelihoods supported through national forest management activities are very important components to all three socio-economic impact zones' socio-economic well-being. Table 80 displays a summary of the total direct, indirect, and induced employment attributable to timber volume sold, livestock grazing, and outdoor recreation on each of the three National Forests. This table does not include employment attributable to Forest Service expenditures or payments to states and counties, since these are not forest planning decision. Alternatives D and E-Modified Departure support the highest levels of employment, due primarily to higher levels of timber volume sold under these alternatives. In contrast, Alternative C would support substantially lower levels of employment associated with activities on the national forests.

Table 80. Total direct, indirect, and induced employment contribution by National Forest, annual average

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	644	726	338	1,241	921	959	1,225	787
Umatilla	483	550	195	1,234	750	818	1,174	655
Wallowa-Whitman	520	596	268	1,323	923	1,043	1,342	715

Table 81. Total direct, indirect, and induced labor income (thousands, 2014 dollars) contribution by National Forest, annual average

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Modified	Alt. E-Modified Departure	Alt. F
Malheur	$18,892	$23,259	$10,124	$53,310	$34,974	$35,833	$51,322	$27,158
Umatilla	$18,616	$24,138	$9,060	$63,368	$35,209	$35,564	$56,315	$29,706
Wallowa-Whitman	$16,630	$21,591	$8,811	$61,067	$39,488	$42,270	$59,016	$27,855

Issue 3: Livestock Grazing and Grazing Land Vegetation

As with many actions that involve the removal of natural resources from public land; livestock grazing, or the removal of forage by domestic animals (primarily cattle and sheep), is a an debated and highly controversial issue. This issue is shaped by opinions and scientific papers advocating a wide range of actions from complete elimination of livestock's use of public lands, to increases in the use of public land by livestock. In dealing with this issue, the Forest Service strives to sustain the health, diversity, productivity, and ecological integrity of the land to meet the needs of present and future generations by using the best available science and an ecological approach to multiple use management.

In this section, the interdependency of social and economic factors and how they relate to national forest management designed to maintain or restore the composition and structure of vegetation will be addressed. These factors include the conditions of and desired condition of grazing land vegetation especially in riparian areas, the potential for disease transmission from domestic sheep to bighorn sheep, and the concern that further restrictions on grazing allotment management would adversely affect livestock operations and the livelihoods of those who graze the forest.

Livestock grazing and grazing land vegetation is discussed in several sections of this chapter including but not limited to: Economic and Social Well-Being, Aquatics, Terrestrial Wildlife, Watershed, and Plants.

Livestock grazing and grazing land vegetation will be discussed as separate topics. Cumulative effects will be discussed together at the end of this section. The economic contributions of livestock grazing and grazing land vegetation are discussed in the Economic and Social Well-Being section of this document.

Changes Made Between the Draft and Final Environmental Impact Statements

Aside from the global changes throughout this environmental impact statement described in the Preface to this document, the following changes were made specifically to this section:

Inaccuracies Corrected in Analysis Assumptions: The use of "authorized" animal unit months in the Draft Environmental Impact Statement and Draft Forest Plan was updated to use "permitted" animal unit months, which do not vary annually, such as when a permit is in non-use status.

Development of additional alternatives: Alternative E was modified into three separate plan revision alternatives in response to numerous comments on the Draft Plan and Environmental Impact Statement. Changes made to grazing were primarily based on concerns regarding the desire for the inclusion of vacant allotments in the analysis of acres of suitable land for livestock grazing and the animal unit months they support. All tables, figures and associated analysis discussions have been updated to incorporate the two modified alternatives: Alternative E-Modified and Alternative E-Modified Departure.

The 2018 Blue Mountains ARCS was also modified from the 2008 Regional ARCS to include updated riparian area grazing guidelines. The grazing guidelines were finalized in late 2017 using the iterative NEPA process between several cooperating county commissioners within the Blue Mountains national forests, the U.S. Fish and Wildlife Service, National Marine Fisheries and Forest Service decisionmakers. Refer to the "Design of Alternatives" section below.

History of Grazing in the Blue Mountains

Although Marcus Whitman brought several head of cattle to the Walla Walla River valley in 1836, more substantial numbers of cattle and sheep were initially brought into northeastern Oregon and southeastern Washington during the 1840s via the Oregon Trail. Native American horse herds were already large and well established by then, having arrived in the Blue Mountains around 1730 after migrating northward from the Santa Fe, New Mexico area.

Livestock grazing on Forest Service land has been essential in meeting the needs of the areas inhabitants, beginning even before the Forest Service was formed in 1905. In the early 1900s, when permits were first issued for livestock grazing, settlers living near Forest Service boundaries could obtain a free use permit to graze up to ten domestic animals on government land during the specified season. In addition, ranchers could graze larger numbers of animals on National Forest System lands, providing they purchased a permit, confined their animals to the allotted area, and salted them according to established guidelines.

The general picture of Forest Service livestock management, beginning in the first decade of the 1900s, is one of initially working to control livestock numbers (the institution of permit systems, assignment of allotments, allocation of permitted livestock numbers, and seasons). This was followed by a period of working to fence national forest and allotment boundaries and to develop water sources to keep permitted livestock where they belonged and to curtail trespass livestock and to keep trespass livestock outside National Forest System lands. This in turn was followed in the mid-1900s by an emphasis on rangeland restoration (seeding and erosion control) and the beginning of development of cross fencing to increase livestock control and implement intensive grazing management systems.

Throughout this period from the very early 1900s through the mid- to late-1900s, there were very large reductions in permitted livestock. Forest Service records indicate a dramatic reduction in permitted numbers and seasons, as well as actual numbers and animal unit months during the first decade or so of Forest Service management. In some cases, numbers permitted were allowed to increase during both World War I and II with permitted use again declining following the war years. Since the World War II, reductions have been relatively steady and slow as management was adjusted on an allotment specific basis to bring stocking rates in line with both land and management capability. Current permitted numbers, seasons, and animal unit months are estimated to be a small fraction of what occurred prior to Forest Service management. Irwin (1994) estimated that animal unit months for the Wallowa-Whitman National Forest decreased from 700,000 in 1915 to about 200,000 in 1985. In 1905, just prior to the establishment of the Wenaha Forest Reserve, the northern half of the Umatilla supported somewhere in excess of 275,000 head of sheep, 40,000 head of cattle, and 15,000 head of horses. By the late 1930s, however, permitted livestock numbers for the entire Umatilla National Forest had been reduced to 88,102 head of sheep and 8,528 head of cattle (Powell 2008). The Wallowa-Whitman closed numerous sheep allotments in the mid-1990s to reduce the potential for disease transmission between the domestic sheep and bighorn sheep.

During the latter 1900s, the emphasis shifted to more intense livestock management and to the application of the best available scientific information. Allotments were cross-fenced into a greater number of pastures and rotation systems were established to ensure rest or deferment (for example, no grazing until after the key forage plants had passed the most critical periods of growth). Permitted livestock numbers continued to trend downward but at a relatively slow pace. Throughout this period, permitted seasons were reduced to conform to standard range readiness criteria. These criteria focused on ensuring that livestock did not enter National Forest System

rangelands until soils were dry enough and plants had passed the most critical periods of growth to ensure that impacts from livestock were minimal. End of season criteria were also set and adjusted based on certain factors, such as minimizing conflicts with recreation, moving before snow accumulation, and ensuring that adequate forage resources remained for large wild ungulate winter range needs. In addition, with the development of allotment cross-fencing, management was able to more actively manage use periods so as to better provide for plant growth, regrowth, and reproduction. In general, these principles are still followed, although improved understanding of plant and soil needs has allowed for adaptive management principles to be followed with regard to seasons of use, as well as authorized numbers, age classes, and types of livestock.

Finally, during the past 20 to 30 years, an awareness of the importance of riparian areas and wetlands and aquatic resources, supported by an increased emphasis on Endangered Species Act listed fish species and habitats, has resulted in implementing intensive grazing management practices. These practices are primarily focused on restoring riparian and stream conditions and on minimizing or avoiding conflict between permitted livestock and the listed fish species and their habitats. During this time period, additional monitoring has occurred to assist in the application of adaptive management principles focused on sustaining permitted livestock use while improving aquatic habitats.

Current trends for riparian and aquatic habitats for each aquatic species were assessed in this analysis, using data from regional-scale effectiveness monitoring using protocols developed in response to requirements of biological opinions for the 1990 Forest Plans as amended by PACFISH and/or INFISH (Archer et al. 2009, Archer and Ojala 2016a, 2016b, 2016c).

This monitoring is done at a larger scale than the Plan Area, but includes all portions of the Plan Area. Implementation of PACFISH and INFISH in their respective areas was designed to forestall any further management-related habitat degradation and to allow for nearly natural rates of habitat recovery. Passive restoration of riparian and aquatic habitats through natural processes appears to be occurring within National Forest System lands based on recent monitoring-based habitat trend analyses (Archer et al. 2009). The “Watershed Function, Water Quality, and Water Uses” section of Chapter 3 discusses these effectiveness monitoring results in greater detail, which will not be repeated here. Instead it will simply be noted that riparian and aquatic habitat conditions are currently trending upward at the scale of the Plan Area, following 15-plus years of management under the 1990 forest plans as amended by PACFISH and/or INFISH, based on these monitoring results.

With localized exceptions, riparian areas in the project area are in improved condition and are trending toward continued recovery (Archer 2016 a-c). Much of the recovery to date has occurred in terms of riparian vegetation with recovery in stream morphology tending to be slower and more localized. In part, this is due to the nature of the processes involved (for example, vegetation can grow and reproduce relatively quickly given the opportunity while hydrologic process recovery takes more time). It is also due to the multiple impacts affecting stream hydrology (such as roads, livestock, Forest Service management, fire management, recreation, and so forth). In most cases, the recovery noted to date has been accomplished in the presence of permitted livestock along with more intense management. Some areas of concern remain but, for the most part, these are relatively localized and can be dealt with through improved management. However, there may be situations where livestock exclusion is the most appropriate or logical treatment.

In addition to the management changes, decreased animal unit months, and increased focus on restoring riparian health and protecting federally listed species that has occurred over the last century, the National Forest System uses the administrative acts, bills, and plans listed in Appendix B, Volume 4 as the legal framework for managing livestock.

Analysis Assumptions

Grazing by livestock or native herbivores can affect grazing land health, including removing plant material, trampling soils (compaction, displacement, and structural damage), and trailing (alteration of water flow patterns). With proper management these impacts are insignificant compared with the natural resilience of the grazing land ecosystem. However, excessive grazing can cause impacts that move a system beyond its short-term ability to maintain functionality. Excessive impacts for an extended period can cause the system to cross thresholds that permanently alter it beyond its ability to recover (Laycock 1994, Miller et al. 1994). It is assumed in this document that, in general utilization of 40 percent or less of the forage on the landscape would result in proper management (see discussion of utilization below).

Grazing land, especially riparian and wetland areas are subject to impacts from a wide variety of other uses and activities. The most critical of impacts come from roads (impacts to riparian/aquatic water relationships), large wild ungulates (impacts primarily to spring and fall range-lands), and fire (impacts from fire exclusion, wildfire/prescribed fire, and natural drought cycles).

All alternatives include management standards or guidelines designed to provide for the sustainability of the grazing lands of the Plan Area. Grazing land health and sustainability is defined by the degree to which the integrity of soils and the ecological processes of grazing land ecosystems are maintained in a healthy functional status over time in response to various disturbance processes. The determination of whether or not grazing lands are healthy depends on the levels of soil stability and watershed function, the integrity of nutrient cycles, plant species composition, and the level of disturbance resiliency relative to site potential.

State and Transition Model (Figure 18) can visually demonstrate the changes to plant communities as a result of natural and/or human caused disturbances. They use the same ecological concepts used to support potential natural vegetation communities and the historical range of variability, paired with additional relevant site data, and knowledge of plant responses. These models are becoming a more important resource in order to assist managers and help determine what the potential of a rangeland ecological site is in order to work towards a desired condition, identify the causal factors for improvement or degradation of an ecological site, or identify if the site has been too severely altered to be able to work towards the potential natural community without active restoration. In a basic sense the “states” in a State and Transition Model shows the range of plant communities possible given the physical rangeland site characteristics, and the “transition” demonstrates the natural or human-caused disturbances that can or have occurred, and what the resulting plant community could be after disturbance. Work by Stringham et al. in 2003 is a more technical reference to explain State and Transition Models, and is within the list of sources cited.

Johnson and Swanson (2005) classify vegetation along a gradient of increasing departure from pristine, native vegetation (reference conditions). Phases A to C are used to describe the distinctive plant communities in a state close to reference, which represents the historic range of vegetation dynamics of a site. Phase A is the most resilient plant community within that state and depicts reference conditions. Phase B shows moderate departure from reference conditions. Phase C is strongly departed from reference conditions. This is the at-risk phase which is the least

resilient and most vulnerable to transition to an alternate state. Sites with vegetation conditions completely departed from reference are classified as Phase D. This phase represents various alternate states possible for a site. Transitions to alternate states can be caused by grazing, alteration of water tables through mining or irrigation, cultivation, fire suppression and other large disturbances. It is important to note that sites in Phase D may still fulfill many ecosystem functions such as forage production and erosion control and may, with additional disturbance, transition to a different and possibly less desirable alternate state.

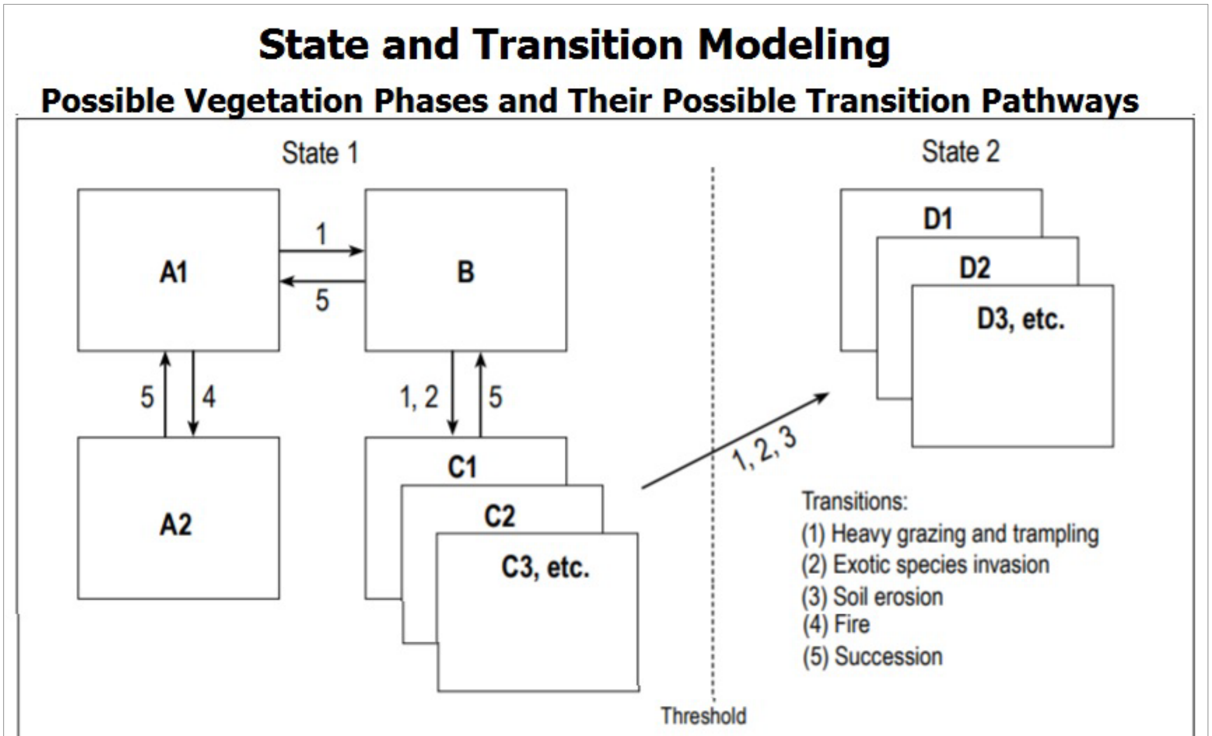


Figure 2—Generalized state-and-transition diagram used in this study. Boxes symbolize phases and arrows are transitions between them. The A, B, and C phases result from increasing grazing-related degradation that is probably reversible by natural succession. The D phases are in a second "state" separated from the first state by an ecologic threshold. Transitions to D phases are caused by loss of native species, invasion of exotic species, and soil erosion; they are probably not reversible by natural succession.

Graphic above was displayed in report prepared by Johnson and Swanson (2005), ***Bunchgrass Plant Communities of the Blue and Ochoco Mountains: A Guide for Managers*****, and published in Gen. Tech. Rep. PNW-GTR-641. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 119 p**

Figure 18. Possible vegetation phases in state and transition modeling

In current usage, "phases" are separated from one another by transitions, most of which are reversible. Phases are separated into "states" when a transition crosses an ecological threshold that is nearly irreversible (Laycock 1991, Stringham and Kreuger 2001). For example, overgrazing may reduce cover by native grasses somewhat, but after a change in grazing regime the bunchgrasses might recover their former dominance; the pristine and somewhat degraded communities would then be considered two phases of a single state. If degradation were to proceed to the point where the native grasses were eliminated and were replaced by highly competitive exotic grasses that would persist even if grazing ceased, then a threshold would be crossed and transition to a new state would have occurred.

The other important component to a State and Transition model is when the ecological site has been so severely disturbed that it has crossed a threshold, in which it will not improve without an

active restoration strategy. In situations where ecological sites have crossed a threshold, restoration through modification of livestock management is not possible. These areas must be managed for modified goals and objectives recognizing a new potential condition and rate of recovery for the new transitioned state.

The desired conditions are defined by layers of management direction. A desired condition is identified where historical range of variability objectives with the Public Land Use Regulations definitions of satisfactory condition (fair range forage condition with an upward trend or better) are met by attaining a mid-seral ecological status with an upward trend or higher condition based on the potential natural community, and recognizes that some communities have been altered, changing the potential natural community. Where ecological sites in state A are managed to maintain their current state, and ecological sites in states B and C are managed to transition toward state A (Stringham et al. 2003, Johnson and Swanson 2005, and Bestelmeyer et al. 2009). In situations where ecological sites have crossed a threshold (Phase D), restoration through livestock management is not possible. These lands are considered to be in unsatisfactory condition, and may have continued livestock use as long as the rate of recovery of these sites is within 70 percent of the natural rate of recovery (USDA Forest Service 2003, p. C-38). Because of the time and expense to restore the condition of sites that have crossed a threshold, there are not any plans to do active restoration in the near future.

The basic measures of grazing land health are tied to the state and transition models with phases A and B presumed to be capable of ensuring long-term sustainability and resiliency. Phase C is assumed to be of concern but is still likely to allow grazing land to operate within the range of natural variability. Phase D is assumed to have resulted from some impact that may have crossed a threshold. Although there is no direct measure of grazing land health parameters associated with these phases, impacts to grazing land vegetation are often directly related and correlated to impacts to the soil resource. Therefore, the use of the phases model is believed to be a good representation of soil stability, nutrient cycles, disturbance resilience, plant species composition and health, and watershed function. Table 89 on page 165 displays acres in each phase.

To provide context, especially for the economic and well-being section of this document, the total animal unit months available for each alternative must be estimated. For a variety of reasons, authorized animal unit months can vary on an annual basis, as well as by National Forest. For this reason, the number of livestock permitted between 2011 and 2013 was averaged for each National Forest and then divided by the number of suitable acres within active allotments in 2013 to obtain an average animal unit month per suitable acre. This was then used to estimate the number of livestock animal unit months for each alternative, including Alternative A, to allow an unbiased comparison between alternatives. This assumes all forage production is equivalent for those acres.

Analysis Methodology

Suitability and Capability for Livestock Grazing

A suitability determination is the process of evaluating a land area through a modeling of suitability and capability for a specified land use (such as permitted livestock grazing). Total land base acres minus (nonsuitable and noncapable) gives the modeled suitability determination. This is a landscape scale estimation based on GIS modeling and is not a site-specific determination. Information including existing vegetation, potential vegetation, and soils was used to make the capability and suitability identification.

Capability is the initial step in determination of suitability and reflects the potential of an area of land to produce resources, supply goods and services, and allow resource uses under an assumed set of management practices and at a given level of management activity. Capability depends upon current resource conditions and site conditions such as climate, slope, landform, soils, and geology, as well as the application of management practices, such as silviculture or protection from fire, insects, and disease. For forest planning purposes, capability does not vary by alternative and is determined once during the forest planning process.

Capability is determined by identifying all the lands within the project area that are National Forest System lands or other lands administered by the Forest Service, then subtracting areas with soil types not meeting criteria to sustain forage or grazing; areas covered by water; and areas with overstory tree canopy cover or unpalatable shrub cover greater than 60 percent. The remaining area is identified as capable rangeland.

Rangeland suitability is further refined from the capable rangeland. Once the capable rangeland is determined, acres that do not have a proposed management area prescription that would allow for grazing are subtracted. Administrative sites, recreation areas, and other areas of specific use are also subtracted, as are areas specifically closed to grazing by past actions or incompatibility of use between resources. The remaining area is identified as suitable rangeland to be used in the forest planning process.

Forest Plan Suitability Determination

For forest planning purposes, the combined “capability” and “suitability” analysis constitutes the suitability determination. This analysis is normally done separately for cattle and for sheep as appropriate, and possibly for other kinds of animals. It is normally completed for each alternative (or grouping of similar alternatives) being considered. Suitability may vary by alternative although capability normally will not.

The capability and suitability analysis and resultant suitability determination is not a decision to graze livestock on any specific area of land, nor is it a decision about or estimate of livestock grazing capacity. The capability/suitability analysis and suitability determination may or may not be used to provide supporting information for a decision to graze livestock on a specific area.

Any landscape area will contain areas that are capable and/or suitable, as well as areas that are modeled as being other than capable and/or suitable. Since the Forest Plan-level suitability determination is based on a landscape scale modeling process and is dealing with a wide variety of very complex landscape parameters (slope, aspect, plant communities, soils, and so forth), it is inevitable that suitable and nonsuitable acres will intermingle on a land base of any significant size. Therefore, these suitability determinations are not intended to imply that livestock will be precluded from being found on lands that may be modeled as other than capable or suitable.

Forage Production Estimates

Estimates of forage production were based on average production (pounds per acre per year) for each grouping of plant associations. Approximately 500 individual plant associations were grouped into the 22 vegetation groups. Each plant association was classified into a temperature-moisture matrix by the area ecologist. Vegetation groups are aggregations of plant associations found in the Blue Mountains (Powell et al. 2007 Johnson 1987, 1992) and represent a combination of temperature and moisture regimes. Table 82 displays the average forage production for each of the vegetation groups. The forage estimates were derived from Johnson 1987 and 1992 field sampled measurements for each plant association.

The estimates in the table are coarse, and even though a single number was used to calculate potential forage, the reality is that production can be variable and influenced by site specifics such as the seral stage of vegetation being analyzed or annual variations due to weather. All of these variables need to be accounted for when this information is used for project level planning. The representative plant association was determined by using the plant association within each vegetation group that was most abundant as indicated by the continuous vegetation survey data.

Table 82. Average forage production by plant association group

Vegetation Group	Representative plant association	Forage production (pounds per acre per year)
Cold Riparian Forest - (Cold RF)	Subalpine fir / aquatic sedge	250
Cold Riparian Herbland - (Cold RH)	Woodrush sedge	700
Cold Riparian Shrubland - (Cold RS)	Willow / aquatic sedge	300
Cold Upland Forest - (Cold UF)	Cws811, Grand fir/ grouse huck	30-500 (200)
Cold Upland Herbland - (Cold UH)	Gs11, green fescue	500-1,300 (900)
Cold Upland Shrubland - (Cold US)	Ss4915, Mountain big sage, needlegrass	50 – 450 (300)
Dry Upland Forest - (Dry UF)	Cwg112, Grand fir pine grass	300 – 600 (450)
Dry Upland Herbland - (Dry UH)	Gb41, Bluebunch wheatgrass	400 – 800 (600)
Dry Upland Shrubland - (Dry US)	Sd9111, Stiff sagebrush / Sandberg's bluegrass	100 to 250 (200)
Dry Upland Woodland - (Dry UW)	Cjs111, western juniper / low sagebrush	300 – 400 (350)
Low Soil Moisture Riparian Forest (Low SM RF)	Ponderosa pine / Common snowberry (floodplain)	200
Low Soil Moisture Riparian Herbland (Los SM RH)	Md3111, Kentucky bluegrass (dry meadow)	600
Low Soil Moisture Riparian Shrubland (Low SM RS)	Willow / Kentucky bluegrass	200
Moderate Soil Moisture Riparian Forest (Mod SM RF)	Black cottonwood / Common snowberry	200
Moderate Soil Moisture Riparian Herbland (mod SM RH)	False hellebore	200
Moist Upland Forest (Moist UF)	Cwf311, Grand fir / Twinflower	<200
Moist Upland Herbland (Moist UH)	Gb5917, Idaho fescue-bluebunch wheatgrass-balsamroot	200 – 1,000 (650)
Moist Upland Shrubland (Moist US)	Sd2911, Mountain big sagebrush / Idaho fescue-bluebunch	230 – 625 (425)
Moist Upland Woodland (Moist UW)	Cjs41, Western juniper / Mountain mahogany / Idaho fescue	300 – 700 (400)
Warm Riparian Forest (Warm RF)	Quaking aspen / Mesic forb	200

The current production figures were developed by multiplying the production figures in Table 82 by the total number of acres in each vegetation group, capability group, and National Forest. The total acres within each vegetation group were derived from the output of the range suitability modeling process described above. The production figures represent the current vegetation conditions, which in the case of the forested groups are heavily influenced by overstory canopy cover. In general, the higher the overstory canopy cover, the lower the understory production. Production for forested areas that were also classified as noncapable was calculated by multiplying the noncapable, forested acres by 50 pounds per acre per year because much of the

area, although being closed canopy, still could provide a minimum amount of forage. These acres are not included in the animal unit month calculations for capacity determinations.

Further information and greater detail are part of the planning record.

Design of the Alternatives

All alternatives are designed to maintain the health, sustainability, and resilience of grazing land as part of the broader landscape. How standards and guidelines would be applied and management direction for ensuring the separation of bighorn and domestic sheep make up the key differences between the alternatives. In addition, suitability for livestock grazing by alternative varies where there is more intensive management required for riparian management areas, botanical areas, Research Natural Areas, federally listed or species at risk plants, federally listed fish or critical habitat, occupied sage grouse habitat, grazing after wild fire, or wild and scenic river corridors.

For all alternatives, authorization of livestock grazing would remain a project-level decision based on guidance provided by the forest plans. This could potentially include vacant allotments.

Alternatives B, C, D, E, and F all vary in the percent utilization of woody and herbaceous vegetation within riparian management areas, but they have the same minimum residual stubble height (at the greenline) of 4 to 6 inches and the maximum bank alteration of 20 percent. Alternatives E-Modified and E-Modified Departure incorporate the 2018 Blue Mountains Aquatic and Riparian Conservation Strategy grazing guidelines, which include an adaptive framework for selecting and adjusting over time, annual use indicators and values based on: 1) their relevance to achieving aquatic and riparian desired conditions; 2) their applicability to a given area; and 3) the status and trends of aquatic and riparian resources in the area, as determined by relevant assessment information (such as the Watershed Condition Framework assessment) at the subwatershed scale and other inventory, assessment and monitoring data and information (such as Multiple Indicator Monitoring, properly functioning condition assessments) at other appropriate scales.

Alternative A would continue current forest plan direction as amended by PACFISH and INFISH requirements. Grazing permit authorizations have diminished since 1990 due to the Federal listing of fish species per the Endangered Species Act and the PACFISH and INFISH amendments to the 1990 forest plans. When the 1990s plans were signed, the permitted animal unit months (AUMs) were 360,000 (separated by national forest, the Malheur was 116,000, the Umatilla 58,000, and the Wallowa-Whitman 186,000). The AUMs for Alternative A in the DEIS were the average of 2007 through 2009 permitted AUMs. These changes resulted in stricter management direction for livestock grazing in riparian areas (Table A-9, Appendix A, Volume 4). Upland grazing has continued to be managed according to direction provided by the Pacific Northwest Region of the Forest Service (Table A-8, Appendix A) during the development of the current plans. Within the Blue Mountains national forests, 219,000 acres would be generally suitable for sheep grazing, and 3,020,000 acres would be generally suitable for cattle grazing. Alternative A does not include specific plan components to reduce the potential for or prevent disease transmission from domestic sheep to bighorn sheep on the Umatilla National Forest, although several allotments have been closed to minimize the effects to bighorn sheep from disease transmission from domestic sheep. The forest plan for the Malheur National Forest contains management direction not to stock livestock pastures within bighorn sheep ranges with domestic sheep. The Wallowa-Whitman Forest Plan states that management of bighorn sheep will be in accordance with a 1982 document "Wild Bighorn Sheep Conflicts with Domestic Livestock

and other Wildlife Ungulates on the Wallowa-Whitman Forest - A Summary Status Report and Interim Program Direction” [Wallowa Whitman Forest Plan, 1990, Wildlife S&G 5, page 4-45]. Similar to the Umatilla, the Wallowa-Whitman has closed several sheep allotments.

For the Umatilla National Forest, utilization of transitory range (where timber harvest has occurred during the last 30 years) shall not exceed 60 percent for domestic livestock.

Table 83. Current management direction for the maximum percent utilization of livestock grazing in uplands

National Forest	Management Level	Forested		Grasslands		Shrubland	
		Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory
Malheur*	Stewardship B	40%	0-30%	50%	0-30%	40%	0-25%
	Extensive C	45%	0-35%	55%	0-35%	50%	0-30%
Umatilla	Stewardship B	40%	0-30%	50%	0-30%	40%	0-25%
	Extensive C	45%	0-35%	55%	0-35%	45%	0-30%
	Intensive D	50%	0-40%	60%	0-40%	50%	0-35%
Wallowa-Whitman	Stewardship B	40%	0-30%	50%	0-30%	40%	0-25%
	Extensive C	45%	0-35%	55%	0-35%	45%	0-30%
	Intensive D	50%	0-40%	60%	0-40%	50%	0-35%
Ochoco	Stewardship B	40%	0-30%	50%	0-30%	40%	0-25%
	Extensive C	45%	0-35%	55%	0-35%	45%	0-30%
	Intensive D	50%	0-40%	55%	0-40%	50%	0-35%

* Does not mention level D.

Table 84. Current management direction for maximum percent utilization of livestock grazing in riparian areas

National Forest	Management Level	Grass and Grass-like		Shrubs	
		Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory
Malheur*	Stewardship B	40%	0-30%	30%	0-25%
	Extensive C	45%	0-35%	40%	0-30%
Umatilla	Stewardship B	40%	0-30%	30%	0-25%
	Extensive C	45%	0-35%	40%	0-30%
	Intensive D	50%	0-40%	50%	0-35%
Wallowa-Whitman	Stewardship B	40%	0-30%	30%	0-25%
	Extensive C	45%	0-35%	40%	0-30%
	Intensive D	50%	0-40%	50%	0-35%
Ochoco	Stewardship B	40%	0-30%	30%	0-25%
	Extensive C	45%	0-35%	40%	0-30%
	Intensive D	50%	0-40%	50%	0-35%

* Does not mention level D.

Alternative B utilizes the status of allotments as of 2013. The estimated numbers of permitted cattle are fewer than Alternative A, and acres suitable for grazing would also be fewer. Permit authorizations for grazing sheep would be slightly reduced to lessen the risk of disease transmission from domestic sheep to bighorn sheep. This alternative identified areas as unsuitable for domestic sheep/goat grazing that were estimated to have a 95 percent probability of contact with wild sheep. It also anticipated the reestablishment of the Canyon Mountain wild sheep herd.

Alternative B and the other plan revision alternatives all include measures (standards and guidelines) to reduce the potential for or prevent disease transmission from domestic sheep to bighorn sheep. Management actions would be in cooperation with state wildlife agencies.

In general, livestock management in riparian areas under Alternatives B through E incorporates the 2008 Pacific Regional Strategy. Alternative B incorporates a utilization guideline within riparian management areas of 40 percent on both herbaceous and woody vegetation. Riparian management areas in Alternative B would have a width of 300 feet on either side of all fish-bearing streams, and 150 feet for non-fish bearing perennial streams, and ephemeral and intermittent streams. The guideline for upland utilization of herbaceous vegetation is 50 percent or less in areas of season long use and of low departure from the desired condition (Table 85). Where a management system is in place (such as deferred rotation or rest rotation) utilization may reach 55 percent in areas of low departure from the desired condition. Where there is moderate or greater departure from desired condition utilization is expected to be 30 percent or less under season long and 35 percent or less with a management system in place. Upland shrub utilization is not expected to exceed 45 percent (Table 86).

In Alternative C the area that would be generally suitable for cattle grazing would be reduced to approximately 786,000 acres, the smallest projection among alternatives. This decrease would result from the classification of riparian areas and subwatersheds with habitat for listed fish species as generally unsuitable for cattle grazing. Riparian management areas in Alternative C would have a width of 300 feet on either side of all streams, regardless of stream class. The area that would be generally suitable for sheep grazing would be reduced to approximately 98,000 acres, also the lowest projection among alternatives. This decrease would result from the classification of subwatersheds within the maximum foray distance for bighorn sheep rams as generally unsuitable for sheep grazing. Any area that was not previously determined to be unsuitable as a result of site factors (slope, vegetation, canopy cover), or was outside of a listed fish subwatershed, or not within 300 feet of a stream was identified as suitable.

In general, livestock management under Alternative C incorporates a utilization guideline within riparian management areas of 10 percent on herbaceous vegetation and 25 percent on woody vegetation. Upland utilization of herbaceous vegetation is a standard of 30 percent under all management systems regardless of departure from the desired condition (Table 85). Upland shrub utilization is a standard not to exceed 25 percent (Table 86).

In Alternative D, grazing permit authorizations for cattle would be greater than the current condition. The assumption is that portions or all of some vacant allotments would be stocked and as a result, suitable acres in active allotments would increase. Permit authorizations for grazing sheep would be slightly reduced to reduce the risk of disease transmission from domestic sheep to bighorn sheep. This alternative identified areas unsuitable for domestic sheep and goat grazing that would provide a moderate level of confidence (greater than 50 percent) of no contact with wild sheep by incorporating the 95 percent confidence area. It does not consider the reestablishment of the Canyon Mountain wild sheep herd.

Management of livestock in riparian areas is the same as proposed in Alternative B, except that the riparian management areas are between 50 and 100 feet in width. Upland grazing would have a desired utilization of herbaceous vegetation of 40 percent or less in areas of season long use and of low departure from desired condition (Table 85). Where a management system is in place (such as deferred rotation or rest rotation) utilization may reach 50 percent in areas of low departure. Where there is moderate or greater departure from desired condition utilization is

expected to be 40 percent or less under season long and 45 percent or less with a management system in place. Alternative D has no utilization guideline for upland shrubs (Table 86). Most other grazing management under Alternative D would use desired conditions to address livestock grazing and rangeland vegetation rather than the standards and guidelines proposed for all other alternatives.

Table 85. Maximum percent utilization of key grass and forbs species within upland sites*

Management System	Alt. B Departure from Desired Condition (guideline)		Alt. C Departure from Desired Condition (standard)		Alt. D Departure from Desired Condition (guideline)		Alt. E, E-Mod., E-Mod. Dep., and F from Desired Condition (guideline)	
	Low	Moderate or Greater	Low	Moderate or Greater	Low	Moderate or Greater	Low	Moderate or Greater
Season long	50	30	30	30	45	40	35	30
Management systems that incorporate deferment, rest, rotation	55	35	30	30	50	45	40	35

* Utilization should be based on a point in time measurement. It includes all use by permitted livestock, wildlife, insects, wildfire, or recreational use. Utilization will be based on height-weight curves and/or ocular estimates or other approved measures. Utilization is based on key species.

Low-moderate departure: phase A or B; Moderate or greater departure: phase C or D.

Table 86. Allowable shrub utilization

Alternative B	Alternative C	Alternative D	Alternatives E, E-Modified, E-Modified Departure & F
Guideline Upland shrub utilization should not exceed 45 percent as determined by any science-based method.	Standard Upland shrub utilization shall not exceed 25 percent as determined by any science-based method.	This alternative has no corresponding management direction.	Guideline Upland shrub utilization should not exceed 40 percent as determined by any science-based method.

Alternatives E and F would be the same as Alternative A regarding permitted numbers for cattle and acres suitable for grazing. Permit authorizations for grazing sheep to reduce the risk of disease transmission from domestic sheep to bighorn sheep for both alternatives would be the same as in Alternative D.

The desired upland utilization for both E and F for herbaceous vegetation is 35 percent or less in areas of season long use and of low departure from desired condition. Where a management system is in place (such as deferred rotation or rest rotation) utilization may reach 40 percent in areas of low departure (Table 85). Where there is moderate or greater departure from desired condition utilization is expected to be 30 percent or less under season long and 35 percent or less with a management system in place. Upland shrub utilization is not expected to exceed 40 percent (Table 86).

Both Alternative E and F follow the guidelines of the 2008 Pacific Regional Strategy. Alternative E incorporates a utilization guideline within riparian management areas of 25 percent on woody and herbaceous within bull trout watersheds and 40 percent in all other watersheds. Alternative F incorporates an additional utilization guideline for watersheds containing anadromous fish of 35 percent for the Umatilla and Wallowa-Whitman National Forests.

Additionally, both alternatives include an objective designed to improve a portion of rangeland in Phase C or D to Phase A or B for all three National Forests. These two alternatives also incorporate the Oregon Department of Fish and Wildlife greater sage-grouse conservation plan components. There are guidelines for fence construction within greater sage grouse habitat, livestock turnout, and forage utilization.

Table 87 shows the percent maximum utilization for Alternatives B through F. Alternatives E-Modified and E- Modified Departure would incorporate the grazing guideline for riparian utilization from the 2018 Blue Mountains Aquatic and Riparian Conservation Strategy, and therefore are not represented in the table.

Table 87. Maximum utilization within riparian management areas*

Measure	Alt. B	Alt. C**	Alt. D	Alt. E	Alt. F
Maximum percent utilization of woody vegetation	40%	25%	40%	• 25% within bull trout spawning and rearing reaches • 40% for all other watercourses including anadromous fish reaches	• 30% in bull trout spawning and rearing habitat (all three National Forests) • 35% in anadromous fish reaches (Umatilla and Wallowa-Whitman) • 40% outside bull trout spawning and rearing habitat (Malheur) • 40% outside anadromous fish reaches (Umatilla and Wallowa-Whitman)
Maximum percent utilization of herbaceous vegetation	40%	10%	40%	• 25% within bull trout spawning and rearing reaches • 40% for all other watercourses including anadromous fish reaches	• 30% in bull trout spawning and rearing habitat (all three National Forests) • 35% in anadromous fish reaches (Umatilla and Wallowa-Whitman) • 40% outside bull trout spawning and rearing habitat (Malheur) • 40% outside anadromous fish reaches (Umatilla and Wallowa-Whitman)

* In addition, the minimum residual stubble height (applies at the greenline) for all alternatives is 4 to 6 inches.
** For Alternative C, this is a standard for maximum utilization within riparian management areas.

Alternatives E-Modified and E-Modified Departure would use 2013 permitted animal unit months and include vacant allotments to determine acres suitable for livestock grazing. Permit authorizations for grazing sheep to reduce the risk of disease transmission from domestic sheep to bighorn sheep for both alternatives would be consistent with current 2013 authorizations, which have already completed the analysis for bighorn sheep risk of contact, and allotment environmental analysis.

The desired upland utilization for both Alternatives E-Modified and E-Modified Departure for herbaceous vegetation would be the same as Alternatives E and F. Additionally, both alternatives include an objective designed to improve a portion of rangeland in Phase C or D to Phase A or B for all three National Forests. These two alternatives also incorporate additional guidance within the greater sage-grouse habitat that was derived from the Forest Service and BLM's "Idaho and Southwestern Montana Greater Sage-grouse Land Use Plan" and the BLM's "Oregon Greater Sage-grouse Resource Management Plan." There are guidelines for fence construction within greater sage grouse habitat, livestock turnout, and forage utilization.

Both Alternatives E-Modified and E-Modified Departure incorporate the 2018 Blue Mountains Aquatic and Riparian Conservation Strategy grazing guidelines for riparian grazing management, as well as its other standards and guidelines for grazing. The purpose of this guideline is to

manage livestock grazing to help attain and maintain aquatic and riparian desired conditions over time. Specifically, it is intended to maintain or improve vegetative and stream conditions, help ensure the viability of aquatic species, provide important contributions to the recovery of federally listed species, and facilitate attainment of State water quality standards.

The annual livestock use and disturbance indicators described below should be applied to help achieve, over longer timeframes, conditions at site and watershed scales that enable attainment and maintenance of desired conditions. The values specified below are starting points for management. Only those indicators and numeric values that are appropriate to the site and necessary for maintaining or moving towards desired conditions should be applied.[16] Specific indicators and indicator values should be prescribed and adjusted, if needed, in a manner that reflects existing and desired conditions and the natural potential of the specific geo-climatic, hydrologic and vegetative setting in which they are being applied.[17] Indicators and indicator values should be adapted over time based on long-term monitoring and evaluation of conditions and trends. Alternative use and disturbance indicators and values, including those in current Endangered Species Act consultation documents or allotment management plans without federally listed species, or allotment analysis decisions, may be used if they are based on best available science and monitoring data and meet the purpose of this guideline.

1. Where desired conditions for water quality, aquatic habitat, and riparian vegetation have been attained[18] and riparian vegetation is in late-seral condition,[19] protect or maintain those conditions by managing annual livestock grazing use and disturbance as follows: [20]
    - maintain a minimum of 4-inch residual stubble height [21] of key herbaceous species on the greenline;
    - utilize no more than 30-45 percent of deep-rooted herbaceous vegetation in the active floodplain[22] and, as needed, in other critical portions of the riparian management area;
    - limit streambank alteration[23] to no more than 20-25 percent; and

[16] Not all indicators may apply to a particular site. For example, stubble height is a meaningful indicator for lower gradient streams where herbaceous vegetation plays an important role in stabilizing streambanks. It is generally less useful for steeper channels, where channel morphology is controlled by coarse substrates. Moreover, not all numeric values may apply to a particular site (e.g., sites with short graminoids).

[17] Indicator values for specific sites should be determined based on consideration of local conditions including, but not limited to, the degree of departure between existing and desired conditions, the current and desired rate of improvement, site sensitivity to grazing, grazing season, the presence of special status species (e.g., federally listed species, Regional Forester's sensitive species) that are sensitive to grazing, whether or not water quality standards and related requirements (e.g., TMDLs for impaired waters) are being met, and the site's importance in maintaining or attaining those standards and requirements. Consideration of these conditions is especially important in prescribing specific stubble height values within the 4-inch to 6-inch range and streambank alteration values within the 15-20% range.

[18] Assessment of conditions and trends should be based on best available information at a variety of spatial and temporal scales. Site-specific information is particularly important.

[19] Late seral conditions means the existing riparian vegetation community is similar to the potential natural community composition (per Winward 2000).

[20] Per PACFISH/INFISH Monitoring, Multiple Indicator Monitoring (BLM Technical Reference 1737-23) protocols or comparable methods for stubble height, streambank alteration, and use of woody species. Per Bureau of Land Management protocols (BLM/RS/ST-96/004+1730) or comparable methods for herbaceous utilization.

[21] Stubble height criteria apply at the end of the grazing period, when that period ends after the growing season. When the grazing period ends before the growing season does, stubble height criteria can be applied at the end of the grazing period or the end of the growing season.

[22] Active floodplain is defined as the area bordering a stream inundated by flows at a surface elevation that is two times the maximum bankfull depth (measured at the thalweg).

[23] Streambank alteration criteria apply within 1-2 weeks of removal of livestock from each pasture.

- limit use of woody species to no more than 30-40 percent of current year's leaders along streambanks and, as needed, in other critical portions of the riparian management area.

2. Where desired conditions for water quality, aquatic habitat, and/or riparian vegetation have not yet been attained, but conditions are moving towards those desired conditions,[18] enable continued recovery by managing annual livestock grazing use and disturbance as follows:
   - maintain a minimum of 4-inch to 6-inch residual stubble height of key herbaceous species on the greenline;[17]
   - follow the criteria for utilization of deep-rooted herbaceous vegetation, streambank alteration, and use of woody species described in number 1 above.
3. Where desired conditions for water quality, aquatic habitat, and/or riparian vegetation have not been attained and conditions are not moving towards those desired conditions[18], enable recovery by managing annual livestock grazing use and disturbance as follows:
   - maintain a minimum of 6-inch residual stubble height of key herbaceous species on the greenline;
   - utilize no more than 30-35 percent of deep-rooted herbaceous vegetation in the active floodplain and, as needed, in other critical portions of the riparian management area;
   - limit streambank alteration to no more than 15-20 percent;[17] and
   - limit use of woody species to no more than 20-30 percent of current year's leaders along streambanks and, as needed, in other critical portions of the riparian management area.

Grazing Land Vegetation – Affected Environment

Grazing lands have been affected by a wide variety of natural and human influences. The human influences have often been concurrent throughout the Forest Service and a result of an increase in multiple use of the land, as well as the application of the emerging and developing science of land management.

Rangeland Vegetation

Indicators for rangeland vegetation within the Blue Mountains national forests include:

- Rangeland and riparian vegetative composition and condition
- Grazing land phases and progress towards achievement of desired conditions
- Fire exclusion and extinguishment

Rangeland and Riparian Vegetative Composition and Condition

Grazing lands provide forage for wildlife, permitted livestock, and wild horses, as well as habitat for a wide variety of animal and plant species, including rare or unique plant species and communities. Grazing lands and associated plant communities also provide important watershed values, including soil protection and maintenance, high quality water storage and slow release, and biodiversity. Other intrinsic values associated with rangelands include maintenance of open space, visual beauty, and areas for recreational activities.

Rangelands are a key component of the Plan Area and account for approximately 765,000 acres, or about 16 percent, of National Forest System lands of the 4.9 million acres within the Blue Mountains national forests, excluding the Hells Canyon National Recreation Area. Including the additional grazable forest lands, the total grazing land within the Plan Area is approximately

3,395,000 acres, or approximately 69 percent of the Blue Mountains national forests. The distribution of these lands is displayed in Table 88.

Table 88. Grazing land for each national forest

National Forest	Total Acres	Rangeland (acres)	Grazable Forestland (acres)	NFS Lands Classified as Grazing Land (percent)*
Malheur	1,700,000	230,000	1,270,000	88%
Umatilla	1,400,000	240,000	570,000	58%
Wallowa-Whitman	1,800,000	295,000	790,000	60%

* Total of rangeland and grazable forestland

In 1995 PACFISH and INFISH amended the 1990 Forest Plans to include more restrictive measures designed to protect, conserve and manage riparian habitat for protected resident and anadromous fish species. Monitoring of the effectiveness of these measures began in 2001 as required by the PACFISH/INFISH biological opinion. To date, repeat PACFISH/INFISH biological opinion sampling has been completed on more than 200 monitoring reaches in the Blue Mountains (Archer et al. 2009).

Current trends for riparian and aquatic habitats for each aquatic species were assessed in this analysis, using data from regional-scale effectiveness monitoring using protocols developed in response to requirements of biological opinions for the 1990 Forest Plans as amended by PACFISH and/or INFISH (Archer et al. 2009, Archer and Ojala 2016a, 2016b, 2016c).

This monitoring is done at a larger scale than the Plan Area, but includes all portions of the Plan Area. Implementation of PACFISH and INFISH in their respective areas was designed to forestall any further management-related habitat degradation and to allow for nearly natural rates of habitat recovery. Passive restoration of riparian and aquatic habitats through natural processes appears to be occurring within National Forest System lands based on recent monitoring-based habitat trend analyses (Archer et al. 2009). The “Watershed Function, Water Quality, and Water Uses” section of Chapter 3 discusses these effectiveness monitoring results in greater detail, which will not be repeated here. Instead it will simply be noted that riparian and aquatic habitat conditions are currently trending upward at the scale of the Plan Area, following 15-plus years of management under the 1990 Forest Plans as amended by PACFISH and/or INFISH, based on these monitoring results.

At the scale of the Blue Mountains, favorable trends have been observed in 18 of 24 aquatic and riparian habitat variables measured at managed sites and observed differences in seven of the variables are statistically significant PACFISH/INFISH biological opinion data. In addition, large differences remain in several variables between managed and reference sites. Vegetative variables are improving at a faster rate than physical habitat (channel) variables. While PACFISH/INFISH biological opinion monitoring points within areas managed for permitted livestock tend to be at a lower current condition relative to specific parameters than are reference sites (not grazed by permitted livestock), the difference may or may not be significant, depending on the specific parameter. For example, while there are differences in bank angle (favoring the reference sites), there is no apparent difference in bank stability between reference and managed areas, although there were apparent improvements in the reference sites based on repeat sampling. Further, repeat monitoring findings show little difference in effective ground cover between reference and

managed sites, although green-line cover was greater at the reference sites than at the managed sites. This trend was also borne out by sampling of cross-section vegetation. One key at the managed sites was that nonnative plant cover was consistently greater than on the reference sites.

Aquatic and riparian habitat conditions across the Malheur National Forest, are generally improving or showing non-significant trends depending on the indicator, based on PACFISH-INFISH Biological Opinion trend monitoring (Archer and Ojala 2016a). In the Middle Fork John Day and Upper John Day subbasins, the majority of indicators show no significant change, however anywhere from one to three indicators show significant improvement. PACFISH-INFISH Biological Opinion monitoring results indicate that spring Chinook salmon habitat within the Malheur National Forest is being maintained, is slowly improving through natural processes on National Forest System lands and is supporting viable Middle Columbia River spring Chinook salmon populations. Based on PACFISH-INFISH Biological Opinion monitoring at integrator sites across the Umatilla National Forest, most riparian and aquatic habitat indicators are showing nonsignificant trends, with meaningful changes in 3 of 10 indicators, going in either direction (Archer and Ojala 2016b). Monitoring results suggest that spring Chinook salmon spawning and rearing habitat within the Umatilla National Forest is being maintained and slowly recovering in some subbasins, and that uncertain habitat recovery through natural processes warrants continued monitoring in others, as well as effective implementation of protective habitat management strategies. Based on PACFISH-INFISH Biological Opinion monitoring at integrator sites across the Wallowa-Whitman National Forest, most riparian and aquatic habitat indicators are showing non-significant changes, with meaningful changes in four indicators, going in either direction (Archer and Ojala 2016c). Monitoring results indicate that spring Chinook salmon spawning and rearing habitat within the Wallowa-Whitman National Forest is being maintained and slowly recovering in some subbasins and that uncertain habitat recovery through natural processes warrants continued monitoring in others as well as effective implementation of protective habitat management strategies.

Overall, PACFISH-INFISH Biological Opinion monitoring tends to show a more stable riparian condition at the reference sites. While certain parameters recorded lower values at the managed sites relative to the reference sites, the raw data shows that, in general, the sites open to livestock grazing were improving in the presence of managed livestock grazing.

In the case of riparian areas and wetlands, this monitoring information, combined with long-term camera point monitoring and professional observation, indicates that there has been recovery in many areas for many of the parameters most closely associated with livestock grazing effects (managed sites). However, this has not occurred to the extent that all sites most associated with livestock grazing effects, as well as road or recreation effects, have recovered to the point that they fully meet desired conditions.

These findings are supported by information, such as long-term camera points, dating, in some cases, to the late 1920s (Reid et al. 1991). These older photos, with periodic retakes, initially show extremely degraded riparian/aquatic systems with a virtual lack of woody or herbaceous vegetation, raw and down cut stream banks, and a significantly lowered water table. Following the camera points through time shows a dramatic increases in herbaceous vegetation (often beginning with Kentucky bluegrass followed by sedges and rushes) followed by increases in riparian hardwoods where adapted to the soils and the site. This is all accompanied by raising of the streambed, stabilization of the stream banks, and a significant raising of the water table. In some areas, this has occurred at a much faster rate than in others. And, in general, certain parameters respond more quickly than others. For example, effective ground cover tends to

respond relatively quickly to improved management while recovery of shrubby vegetation is slower, and recovery of stream bank stability, bank angle, and general stream morphology occurs only within an extended timeframe. There are relatively localized areas where grazing continues to impact recovery (primarily by livestock but includes large wild ungulates in some areas, and wild horses in the Murderers Creek Wild Horse Territory), but it can also include the effects of roads and recreation (such as riparian dispersed camping and all-terrain vehicles).

With specific areas of concern remaining, many riparian areas and wetlands have improved relative to reference conditions (and relative to the early 1900s). It is believed that recovery is continuing at a relatively slow but steady rate. In some instances, this recovery may be accomplished through improved management of the impacting activities while in other cases exclusion of specific uses or activities or active restoration activities may be needed. Efforts have been ongoing to reduce the amount of time livestock have access to streams and the potential for trampling causing streambank alteration or stepping on redds. In some cases, the most effective method of protection which set stream habitat improvement on an accelerated trajectory was construction of livestock exclusion fences in critical areas on all three National Forests.

Grazing Land Phases

The occurrence and persistence of a specific plant community on a site is dependent on site specific factors ranging from disturbance factors such as wildfire, drought, livestock grazing, and browsing to more natural factors such as soil structure, soil moisture, shade, plant dominance or life cycle, competition from other plants and topography. Grazing lands are dynamic systems where, at any point, the interaction of physical and biological factors shapes the plant community and the occurrence of specific species. In response to disturbance, the vegetation of a given site may change in composition, dominant species, and vegetation structure. In resilient ecosystems, these changes are readily reversible by successional processes. Large or ongoing disturbances may modify ecosystem processes and feedbacks beyond the limit of ecological resilience and result in the transition to an alternate state with limited potential for recovery (Westoby et al. 1989, Stringham et al. 2003, Briske et al. 2008). These are the primary assumptions of state and transition models, which describe known and anticipated pathways of vegetation dynamics in relationship to disturbance factors (Stringham et al. 2003, Briske et al. 2008).

The ability of a grazing land ecosystem to adjust to change depends upon the system’s capacity to positively respond to disturbance events (or at least to respond in a minimally negative manner with the ability to recover in a reasonable timeframe). Response indicators include (1) moving native vegetative cover and species composition toward potential natural communities, (2) age class distribution indicates adequate reproduction is occurring, (3) other plant community attributes indicate there is sustainment (levels are being maintained) or improvement of soil stability and nutrient storage and cycling.

State and transition models are useful tools to evaluate the condition of rangelands. A number of state and transition models for bunchgrass plant communities have been developed for the Blue Mountains (Johnson and Swanson 2005). Others have been derived from reference conditions of ecological site descriptions. These models are based on local vegetation data and expert opinions. Transitions between states are generally described by biotic thresholds based on vegetation composition.

Johnson and Swanson (2005) classify vegetation along a gradient of increasing departure from pristine, native vegetation (reference conditions). Phases A, and B are used to describe the distinctive plant communities in a state close to reference, which represents the historic range of

vegetation dynamics of a site. Phase A is the most resilient plant community within that state and depicts reference conditions. Phase B shows moderate departure from reference conditions. Phase C is strongly departed from reference conditions. This is the at-risk phase, which is the least resilient and most vulnerable to transition to an alternate state.

Sites with vegetation conditions completely departed from the reference condition are classified as Phase D. This phase represents various alternate states possible for a site. Examples for Phase D include potential green fescue meadows now dominated by forbs and annuals, riparian meadows seeded with nonnative species like orchard grass and meadow foxtail, rangelands invaded by nonnative species like star thistle and ventenata, and conifer encroachment of grass and shrublands that are now void of bunchgrasses. Transitions to less desirable or more desirable phases can be caused by grazing, alteration of water tables through mining or irrigation, cultivation, fire suppression, and other large disturbances. It is important to note that sites in Phase D may still fulfill many ecosystem functions, such as forage production and erosion control, and with additional disturbance, may transition to a different, either less or more, desirable state.

For forest plan analysis, current vegetation survey plots were assigned to phases and states using vegetation attributes and surface cover. Soil erosion, compaction, or other alterations were not directly measured. Plant composition thresholds can be inadequate indicators of ecosystem resilience and future ecosystem behavior (Bestelmeyer 2006). Transitions across such biotic thresholds may be reversible given enough time and changes in management activities. Transitions across abiotic thresholds (such as loss of topsoil) are typically nonreversible without extensive restoration activities. Due to uncertainty regarding thresholds and sparse data for state and transition model validation, rangeland was classified into two categories: Phases A and B include sites with little to moderate departure from reference, and Phases C and D include sites that are strongly to completely departed from reference conditions and are either at risk to transition or have transitioned to an alternate state. Recovery to a previous state would require active restoration. Table 89 displays the percent of plots by National Forest and phase type.

Table 89. Summary (acres) of current vegetation survey plot phases for the existing condition (Alternative A) for each national forest

Phases	Malheur	Umatilla	Wallowa-Whitman
A or B grazable forestland	1,028,700 (81%)	535,800 (94%)	718,900 (91%)
C or D grazable forestland	241,000 (19%)	34,200 (6%)	71,100 (9%)
Total grazable forestland	**1,270,000**	**570,000**	**790,000**
A or B rangeland	59,800 (28%)	98,400 (43%)	118,000 (42%)
C or D rangeland	170,200 (72%)	141,600 (57%)	177,000 (58%)
Total rangeland	**230,000**	**240,000**	**295,000**

Desired conditions for National Forest System lands are best represented by Phases A and B (little to moderate departure from reference conditions). However, a variety of past activities, such as livestock grazing, mining, and logging, have significantly altered rangelands and forestlands. Many of these activities predate the establishment of these national forests and have lasting effects on the structure and composition of vegetation cover.

In the Blue Mountains, grazeable forestland sites represent the majority of the forage production. Within the Umatilla and Wallowa-Whitman National Forests, distribution among grazeable

forestland phase groupings are similar, with 91 to 94 percent in Phases A and B (Table 89). Within the Malheur National Forest, 81 percent of the grazeable forestland is in Phases A and B. Much of Phases C and D grazeable forestlands within the Malheur National Forest is in the hot, dry upland forest type (ponderosa pine and fescue/mahogany/bitterbrush) that has probably been influenced by a variety of impacts, including wildfire followed by grazing, leading to the elimination of species, such as fescue or mountain mahogany.

True rangelands make up a relatively small component of the Blue Mountains national forests. The general condition of rangelands appears more departed from reference conditions than forestlands. Within the Umatilla and Wallowa-Whitman National Forests, Phases A and B rangelands account for 42 or 43 percent of rangeland (Table 89). For the Malheur National Forest, about 30 percent of rangeland is categorized in Phases A and B. As with the grazeable forestlands, most of the Phases C and D rangelands may be the result of activities that pre-date the establishment of the Blue Mountains national forests. Whether or not these sites have indeed crossed a threshold and transitioned to an alternate state has to be analyzed on a case-by-case basis.

Forage conditions on grazeable rangelands and forestlands have been evaluated during the last 50 years using condition and trend monitoring (via the Parker Three-step method). Data from monitoring transects can serve as indicators of general rangeland conditions in the Plan Area. During the 1950s, average forage conditions were very poor; with average Parker scores of 15 out of a possible 100 (more information is available from the planning record). These forage condition ratings have been steadily improving to an average of 56 in the 1990s. From 2000 to 2004, scores have decreased to an average of 47. In the 1950s, a large majority of plots had poor to very poor forage conditions (98 percent of plots scoring less than 40). Conditions have improved significantly, with only 39 percent of sites reported in poor to very poor condition from 2000 to 2004. The rate of improvement has slowed so that the trend for the last 20 years appears static. However, very few plots exhibit an obvious declining trend.

Johnson (2003) and Reid et al. (1991) published findings from 50 years of photographic and vegetation sampling within subalpine grassland ecosystems in the Blue Mountains. The study followed the ecological recovery of sites that had been degraded by early 20th century unregulated grazing. They found that in general there had been substantial improvement in ecological status with increases in native grass species and ground cover that should prevent accelerated soil erosion. While substantial improvement has occurred, they still found room for more improvement.

Skovlin and Thomas (1995) used repeat photography to document long-term changes that had occurred on a variety of Blue Mountains vegetation types between the original series of photos taken prior to 1925 and the repeat photos taken in 1992. They found shifts from grassland to shrub steppe-juniper woodland. Canyon lands were in fair condition and appeared stable. The valley grasslands had improved in general and appeared stable. Surrounding foothills were found to be in poor to good condition with an upward trend in forage values and watershed stability. Mountain grasslands showed increases in conifer encroachment but were in fair condition and stable. Mountain meadows in general showed improvements in species composition, but there were some that had not improved in 75 years. Subalpine grasslands showed increases in conifer encroachment. In another repeat photography publication, Skovlin et al. (2001) also found increases in conifer encroachment onto grasslands.

In general, with proper management as prescribed through the standards and guidelines of all alternatives, it is possible to ensure that across the landscape of an allotment, most sites will be in Phases A or B with some in Phase C, over the life of these Plans. This assumption is based on the current improving trends. In some cases, there will be residual Phase D sites that remain from historic impacts but it is highly unlikely that additional Phase D sites will be created relative to and under proper livestock management. Overall, all alternatives are expected to result in a mosaic of Phases A or B and Phase C sites scattered across the allotment landscape.

The large majority of these sites would be operating within the upper levels of their state and transition models such that they retain their long-term sustainability, are capable of responding to disturbance (to include disturbance by the permitted livestock), and to cycle through various transitions with the potential to ultimately return to their potential natural community. Given grazing patterns that are common to livestock, it is possible that certain sites (such as those preferred by the permitted livestock) could remain at the lower levels of the state and transition model and would not return to their potential plant community in the presence of livestock. However, there are innumerable factors that affect the distribution, stocking rates, grazing systems, season of use, and grazing intensity for each specific site; therefore, we can only assume that phases at specific sites may remain unchanged in a less than potential community. These factors are constantly variable and dependent on each individual manager's method of livestock management which all have a consistent goal of meeting the standards and guidelines within this plan and the term and conditions of their grazing permit. It is assumed that if permitted livestock have the effect of maintaining certain plant communities in specific locales in a lower status, across the landscape the mosaic of plant communities should be within their natural roles.

There are Phase D sites within some allotments that have occurred as a result of many different types of impacts. For example, on some sites, conifer or shrub encroachment or canopy cover may be resulting in alteration of the rangeland plant community due to the lack of appropriate disturbance on overstory vegetation. In many instances, this would be due to a lack of periodic fire. Active restoration in the form of prescribed fire or forested revegetation management could result in the movement of these specific sites back into their near natural cycle, which could then allow them to return to their potential natural plant community. However, other sites have experienced severe enough impacts that they would be expected to remain in a Phase D status for the foreseeable future. It is possible that the effects of impacts from any one or a combination of multiple activities over time have removed essential topsoil necessary for revegetation and that restoration is no longer possible without considerable efforts by management. In some cases where soils have crossed a critical threshold (soil erosion status, plant available water, etc.), restoration to the previous phase may no longer be feasible (Friedel 1991).

The ability of a grazing land ecosystem to adjust to change depends upon the system's capacity to positively respond to disturbance events (or at least to respond in a minimally negative manner with the ability to recover in a reasonable timeframe). Response indicators include moving native vegetative cover and species composition toward potential natural communities; age class distribution that indicates adequate reproduction is occurring; and other plant community attributes that indicate the maintenance or improvement of soil stability, nutrient storage, and cycling.

Fire Exclusion and Extinguishment

Throughout the Forest Service and the Plan Area, the exclusion of fire or rapid extinguishment of fire has been a common practice. This action has many unintentional effects to grazing land vegetation such as:

- It increases coniferous tree cover, which decreases forage production.
- It increases the height, cover, and density of sagebrush, primarily for mountain big sagebrush, which decreases native herbaceous cover. (Quigley et al. 1997) Where sagebrush density and size has progressed to a major extent, it has made it more difficult to reintroduce fire into the disturbance process.
- It increases the population, abundance, and range of Western Juniper (*Juniperus occidentalis*), a species known for its ability to capture precipitation while creating monocultures of trees with very little forage production at the ground level.

Livestock Grazing – Affected Environment

Indicators for livestock grazing within the Blue Mountains national forests include:

- Active allotments include acres and percent of National Forest System land in active grazing allotments and acres in active allotments suitable and capable for grazing
- Forage suitability and utilization includes animal unit months for cattle and sheep
- Grazing after wildfire

Active Grazing Allotments

Table 90 displays the total acres within each national forest in active cattle and sheep allotments, the acres suitable for grazing in those allotments, the percentage of those allotments suitable for grazing, and the percentage by national forest in active allotments.

Table 90. Active allotments and allotments suitable for grazing for each national forest (existing condition 2013)

Measure	Malheur	Umatilla	Wallowa-Whitman
Active livestock grazing allotments (all land types)	1,551,000 acres	826,000 acres	978,000 acres
Percent of national forest in active allotments	91%	59%	54%
Suitable acres in active cattle and sheep grazing allotments (currently active only)	1,299,000 acres	344,000 acres	433,000 acres
Percent of acres suitable for livestock grazing in active allotments	83%	42%	44%
Percent of national forest suitable for livestock grazing (percent suitable within active allotments relative to all National Forest System lands)	76%	25%	24%

Suitability and capability for grazing within allotments is determined by factors that include canopy cover, steepness of slopes, plant production level, and soil condition (land type associations). Active allotments make up about 70 percent of the total land base within the Plan Area. This varies from 54 percent within the Wallowa-Whitman National Forest to 91 percent within the Malheur National Forest. Suitable acres in active allotments range from 44 percent within the Wallowa-Whitman National Forest to 83 percent within the Malheur National Forest.

Suitable acres for livestock grazing on each of the three National Forests in the Plan Area (all National Forest System lands, not just suitable) range from 24 percent to 76 percent, indicating National Forest System lands suitable for grazing make up three quarters of the Malheur National Forest, and a quarter of the Umatilla and Wallowa-Whitman National Forests.

Table 91 displays the existing permitted animal unit months by National Forest. This number reflects how many head of livestock are permitted on the combined allotments.

Table 91. Cattle and sheep animal unit months (AUMs) for each national forest

National Forest	Cattle and Sheep Permitted AUMs (2013)
Malheur	144,100
Umatilla	48,600
Wallowa-Whitman	95,400

Vacant Allotments

Table 92 displays the total acres within each National Forest in vacant cattle allotments, the acres suitable for grazing in those allotments, the percentage of those allotments suitable for grazing, and the percentage by national forest in active allotments. There are no vacant sheep allotments. The capability and suitability analysis and resultant suitability determination is not a decision to graze livestock on any specific area of land, nor is it a decision about or estimate of livestock grazing capacity. The capability/suitability analysis and suitability determination may or may not be used to provide supporting information for a decision to graze livestock on a specific area. Vacant allotments make up about 2 percent of the total land base within the Plan Area. It's 5 percent within the Wallowa-Whitman National Forest and 7 percent within the Malheur National Forest. The Umatilla has no vacant allotments.

Suitable acres in vacant allotments range from 50 percent within the Wallowa-Whitman National Forest to 68 percent within the Malheur National Forest. Suitable acres for livestock grazing on each of the three National Forests comprise 3 percent of the Plan Area.

Table 92. Vacant allotments and allotments suitable for grazing for each national forest (existing condition 2013)

Measure	Malheur	Umatilla	Wallowa-Whitman
Vacant livestock grazing allotments (all land types)	80,500 acres	0 acres	122,500 acres
Percent of allotments vacant in national forest	5%	0%	7%
Suitable acres in vacant grazing allotments	54,800 acres	0 acres	61,100 acres
Percent of acres suitable for livestock grazing in vacant allotments	68%	0%	50%
Percent of national forest suitable for livestock grazing (percent suitable within vacant allotments relative to all NFS lands)	3%	0%	3%

Forage Suitability

In forest planning, the suitability and potential capability of National Forest System lands for producing forage for grazing animals and for providing habitat for management indicator species shall be determined as part of the 1982 Planning Rule, section 219.20. Lands suitable for grazing

and browsing shall be identified and their condition and trend shall be determined. The supply of forage for livestock grazing as well as wildlife species is required to be estimated. An evaluation was conducted in 2010 regarding forage availability and use, in part to determine if there is competition between wild and permitted forage users such that wild ungulate viability is being detrimentally impacted.

In general, the assessment (Countryman 2010) shows that at the landscape scale, forage availability is not a concern. In fact, forage resources are more than adequate to provide for existing and projected future needs of permitted livestock and large wild ungulates while ensuring landscape scale sustainability of rangeland ecosystems.

The 2010 assessment calculated pounds per acre of forage for each plant association group. The basic data for this was derived from the plant association guides completed for the Blue Mountains (Johnson 1987 and 1992). These estimates are at the national forest scale and are influenced by a number of variables, including variation in production on individual sites versus the broader averages, and variations in yearly climate that increase or decrease production. The permitted animal unit months are generally 10 to 20 percent higher than the levels that are actually grazed in the allotments (yearly authorized number). The utilization estimates displayed in Table 93 represent an example of the percent of forage utilization on suitable acres that could be grazed on allotments that year. The forage use was estimated from the currently permitted figures for domestic grazing animals. Each animal unit month assumes approximately 26 pounds of forage consumed per day, or 780 pounds per month. The figures in Table 93 represent forage production within active allotments on lands modeled as suitable for cattle and sheep grazing.

In addition to the percent utilization by sheep and cattle displayed in Table 93, elk and deer are estimated to consume an additional 1.8 to 4.8 percent. At the scale of each national forest, the available information indicates a large excess of forage production that is capable of meeting the current and projected needs for permitted livestock, as well as for large wild ungulate populations in addition to providing for the basic needs of plants, soils, and other natural resources. There may be site specific conflicts, although they are believed to be small in scope and extent.

Table 93. Total forage production (in millions of pounds) and percent utilization by permitted livestock (current use levels) for each national forest (2013)

National Forest	Utilization per Year (cattle and sheep AUMs)	Total Livestock Pounds of Forage Utilization per year (in millions of lbs.)	Production per Year on All National Forest System Lands	Production on Suitable Acres in Active Allotments	Percent Utilization of Suitable Acres in Active Allotments Used by Cattle and Sheep
Malheur	144,100	112	614	558	20%
Umatilla	48,600	38	329	169	22%
Wallowa-Whitman	95,400	74	389	216	34%

There are a number of factors involved in this analysis. First, a portion of National Forest System lands are not within allotments (either active or vacant). All of the forage produced on these lands is therefore available for basic plant, soil, and wildlife needs, as well as other resource needs.

Second, within any given allotment, not all of the acreage is actually capable and suitable for livestock. Unsuitable areas have high canopy cover (greater than 60 percent), steep slopes

(greater than 45 percent for cattle and greater than 60 percent for sheep), or limited forage production potential (based on soil type). These unsuitable areas receive only incidental, if any, livestock grazing. The forage resources on this unsuitable portion are fully available for wildlife and other rangeland related resource needs.

Third, within the areas that are suitable for grazing, current allowable use criteria (utilization standards) are applied to the grazing resource. This means that in most cases 50 percent or less of the forage produced on these acres is available for grazing. The remaining forage production is fully available for other resource and basic plant/soil needs.

Fourth, within any given land area livestock tend to be very selective grazers. Satellite mapping of use by cattle on rangeland shows that they tend to concentrate in or near riparian areas or on lower, more gentle slopes with actual utilization tapering off as distance from water increases and as slope increases (Bailey 2001). Sheep are more able to utilize steeper slopes, but even with permitted sheep grazing, there are use preference patterns across the landscape. By operating under science-based allowable use criteria, the average, actual use of the rangelands tends to be much less than the allowable use levels across the suitable range.

Livestock are only permitted for a limited season of use. In general, this period occurs from about mid-May or early June to late September or mid-October. This means that for the majority of the year there is no competition for space or forage between permitted livestock and wildlife.

In summary, not all of the grazing lands within the Plan Area are both suitable for livestock grazing and are within an allotment. On suitable grazing lands within allotments, annual allowable use criteria restrict the total forage harvested. As a result of livestock grazing preferences and habits, only a portion of the allowable forage is consumed by livestock, with the remaining forage available for wildlife and basic soil/plant and other resource needs.

While much of the impact from introduced plants has come from noxious weeds that are commonly treated to the extent possible, there are infestations that have limited management options and therefore are not commonly treated. Annual invasive grasses, including cheatgrass (*Bromus tectorum*), are aggressive or harmful nonindigenous plant species. Cheatgrass has invaded the Plan Area and can be found in many grassland and shrubland habitats. It normally has minimal influence except where significant disturbances, such as fire and excessive or improper grazing or vegetation management practices, have allowed the species to spread and become common (Quigley et al. 1997).

With changes in the historic disturbance regimes, the long-term resilience of some grazing land plant communities has changed. For example: many dry meadows within the Plan Area have been occupied by Kentucky bluegrass (*Poa pratensis*) (Quigley et al. 1997). This is believed to have occurred as a result of multiple and severe historic impacts to the water-soil relationships of riparian areas. Heavy livestock grazing from the late 1800s through the mid-1900s impacted palatable (and grazing sensitive) native plants and favored the spread of bluegrass. In addition, bluegrass and several other nonnative species were often planted in over-grazed areas as they are more tolerant of grazing than native bunchgrasses and are better competitors against cheatgrass.

Construction of roads and railroads to support logging and recreational activities very often altered hydrologic regimes and resulted in drier riparian and wetland soil conditions. Additionally, there are attempts at wetland draining and water diversions for off-forest and mining water demands which influence riparian and wetland conditions. Actions such as these have impacted the native herbaceous species composition to favor more drought tolerant (often

upland) species, including favoring more drought and impact tolerant bluegrass. Disturbances from wild ungulate populations (i.e., wild horses), increased recreational activities, increasing road densities and road use, altered fire regimes, and forested vegetation management practices have altered hydrologic processes and caused some riparian areas to transition from moist or wet meadows to dry meadows and/or even upland conditions. While the vegetation composition of these sites is strongly to completely departed from historic reference conditions, sites may remain productive for forage.

Similar processes can be observed across upland portions within the Plan Area, such as where increased densities and canopy cover of conifers has negatively impacted understory herbaceous and shrubby plant composition and cover, or where a lack of fire disturbance has resulted in a loss of aspen plant communities (and its herbaceous understory) due to a replacement by conifers. In other areas, upland woody species and communities, such as bitterbrush (*Purshia tridentata*) and mountain mahogany (*Cercocarpus* spp.), have been impacted as historic alteration in natural fire frequency and intensity resulted in invasion of the sites by conifers to the extent that when fire occurs fire intensity is much more severe. The result is that upland shrub species are unable to successfully reestablish (Quigley et al. 1997). When regeneration does occur, excessive and/or improperly timed browsing by ungulates can suppress regeneration and growth.

Road development and the associated increase in recreational driving have increased during the past few decades. The increase in off-road vehicle use has resulted in a corresponding increase in the spread of invasive plants, disturbance of soils (erosion, loss of soil vegetation cover), and disruption of livestock or other rangeland management activities (such as gates left open, water sources damaged, and grazing systems disrupted).

Avoiding Domestic Sheep Potential for Disease Transmission to Bighorn Sheep

Grazing by domestic sheep can increase the risk of disease transmission to bighorn sheep (George et al. 2008). Bighorn sheep are highly susceptible to some strains of Pasteurella. The disease, which is carried by domestic sheep (Foreyt et al. 1994) does not affect domestic sheep; however it is usually fatal to bighorn sheep. Transmission of the disease can occur when bighorn sheep and domestic sheep occupy the same area and come in physical contact with each other (Coggins 2002, Clifford et al. 2009).

As a result of die-offs and suppressed reproduction during the last century, the genetic diversity in bighorn sheep herds has been lost (Schommer and Woolever 2001). At the present time there are no vaccines to protect bighorn sheep from developing pneumonia (Clifford et al. 2009, Schommer and Woolever 2001, Srikumaran et al. 2007, Weiser et al. 2003). The only way to prevent a pneumonia outbreak in bighorn sheep herds is to keep bighorn sheep separated spatially from domestic sheep and goats (Clifford et al. 2009, Dassanayake et al. 2008, Onderka et al. 1988, Schommer and Woolever 2001).

The separation, either spatially, temporally, or both, of bighorn sheep from domestic sheep has been recommended by leading bighorn sheep disease experts (Garde 2005, Schommer and Woolever 2001, Singer 2001). The Western Association of Fish and Wildlife Agencies defines effective separation as spatial and/or temporal separation between wild sheep and domestic sheep or goats resulting in, at most, minimal risk of potential association and subsequent transmission of respiratory disease between animal groups (WAFWA 2010). It is recommended that site-specific solutions for each bighorn sheep population and domestic sheep allotment be developed based on a management strategy appropriate for the complexity of the situation (Schommer and Woolever 2001). Each of the alternatives proposed in this document would take this approach; however,

given the complexity of the issue in the Blue Mountains, each alternative would have pros and cons for minimizing the risk of contact between domestic and bighorn sheep.

Alternatives were evaluated on their merits for providing separation and minimizing likelihood of contact between domestic sheep and the 16 known bighorn sheep populations within and adjacent to the Blue Mountains national forests.

Those alternatives that provide the most summer source habitat in areas identified as unsuitable for domestic sheep grazing and the fewest acres of rangelands considered suited for domestic sheep grazing are considered the best options for bighorn sheep population persistence. The Wallowa-Whitman and the Umatilla National Forests would have a large portion of habitat in areas identified as unsuitable for domestic sheep grazing for all alternatives. Although Table 86 on page 158 displays acres of rangelands suitable for domestic sheep grazing, not all of those acres are currently being grazed or would be grazed by domestic sheep. Many of the acres that could be grazed by domestic sheep are currently designated as cattle allotments, and, although technically they could be grazed by sheep, it would require a change in the type of livestock permitted on the allotment. For more information please refer to the “Terrestrial Wildlife Species Diversity and Viability” section of Chapter 3.

Forage Utilization by Livestock

The lessons offered from several range-experienced authors regarding grazing and related studies are that utilization levels that maintain long term health, recovery, and resilience to disturbance are highly variable and depend on site specific conditions; and that stocking rates and grazing systems are important for improving rangeland conditions. The Blue Mountains Forests use forage utilization as a trigger for livestock management pasture moves for maintenance or improvement of resource conditions.

Some authors criticized using utilization data to make grazing land management decisions. Burkhardt (1997) claims that both utilization and stubble height methods are “likely the least effective management tool” and notes that these were developed to manage season-long grazing. Burkhardt also believes proper season of use and rest are far more effective for addressing most riparian grazing problems. McKinney (1997) notes the problems associated with measuring utilization when averages are calculated based on plant-by-plant observations. McKinney also maintains that overgrazing does not occur until after the grazing animal makes more than one visit to the plant.

Despite these criticisms there is no denying that estimating levels of utilization in order to achieve proper stocking rates has a long history in range management. Early authors investigated the effects of different stocking rates and utilization levels on above-ground biomass, forage production, cover, and other vegetation attributes, as well as livestock performance. These authors support using proper utilization levels to maintain and improve forage production and key species (Holechek 1988). For example, Cook (1977), working in sagebrush-grass range, concluded that 25 percent utilization on key forage plant species was reasonable for late spring and summer use and that 50 percent utilization was the maximum use that should occur in the winter. Skovlin et al. (1976) also reported that light stocking (34 percent for bluebunch wheatgrass and less for Sandberg bluegrass) provided a substantial increase in grazing capacity and better cattle gains per head than moderate or heavy stocking. It also provided the highest game density under dual use. Regarding sagebrush-bunchgrass range in southeastern Oregon, Hyder (1953) concluded, “… although 50 percent utilization is generally considered to be moderate, it probably represents

excessive cropping on the range under consideration because of the large proportion of poor and fair range condition."

Clary (1995) examined vegetation and soil responses to grazing simulation on riparian meadows and found that 10 cm or greater stubble height appears to be required to ensure full biomass production in mountain meadow sedge communities. He concluded, "If utilization guidelines are used, those rates that do not exceed 30 percent of the annual biomass production will likely maintain production the following year," and that grazing these communities "once [growing] annually to a 5 cm stubble height in the spring, or to a 10 cm stubble height in late summer, or at a utilization rate exceeding 30 percent of the total annual biomass production can reduce herbage production significantly." These recommendations apply only to maintaining or enhancing production and do not address the issues of stream bank stability and channel maintenance.

Holechek (1992) found that the most effective management strategy on Chihuahuan Desert rangelands was to use a conservative stocking rate (30 to 35 percent use of forage) and that this was a critical factor in the superior vegetation, livestock, and economic performance on the College Ranch at New Mexico State University compared to surrounding rangelands. Holechek (1993) summarized the importance of stocking rate and residues and concluded (Holechek et al. 1994) that conservative stocking (about 30 percent average use) can improve the herbaceous understory even on mesquite-infested range.

Hart et al. (1989 and 1993) found that proper stocking rates and grazing intensities were more important than grazing systems in improving rangeland vegetation in Wyoming. Hughes (1990) reported that on the Beaver Dam Slope Allotment (Arizona Strip District, BLM), downward trends were recorded between 1970 and 1982 at average utilization levels of 36 percent (ranging from 10 to 70 percent), while this same allotment showed an upward trend between 1981 and 1989 after utilization levels were adjusted to an average of 22 percent (ranging from 11 to 34 percent).

Holechek (2000) described conservative utilization as 31 to 40 percent and moderate as 41 to 50 percent and believed that managers should avoid heavy grazing (exceeding 50 percent). Holechek (2006) more recently concluded that in arid and semiarid areas, grazing can have positive impacts on forage plants compared to exclusion if average long-term use levels do not exceed 40 percent. The growth rate of replacement leaves and shoots increases following defoliation. Expanding leaves tend to grow longer on defoliated plants than on undefoliated plants (Langer 1972), and the photosynthetic rate of the regrowth leaves is higher than that of same-age foliage on undefoliated plants (Briske and Richards 1994).

Grazing after Wildfire

The impacts of grazing management before and after a fire have a dramatic effect on the response of vegetation to the fire and to what can be expected in the long term. The need for increased intensity of grazing management on burned areas can be understood by realizing the potential change in the plant community and associated animal response that can result from a burn (Clark and Miller 2001).

The response of individual plant species to fire varies between and within species. Moreover, this response is influenced by a variety of fire parameters, including intensity, severity (e.g., amount of organic matter consumed), residence time, soil heating, season of burn, and time since last fire. These parameters can vary significantly among fires and within a fire. These variations can and will cause differences in the response of individual species and the community as a whole. In

addition, numerous physical and climatic factors (e.g., fuel condition, weather, slope, and aspect), as well as biological factors (plant morphology and physiology) will influence post-fire effects on plant communities. This includes direct effects, such as the ability of individual species to recover from the effects of fire.

Expected recovery potential is a function of fire severity. Johnson (1998) reported that in lightly burned areas (low severity fires) the expected recovery is fairly quick and a natural recovery of one to two years would be expected. Moderately burned areas (medium severity fires) have a modest recovery rate of two to five years. Heavily burned (high severity fires) have a slow natural recovery and may require five or more years to recover.

Grazing Land Vegetation – Environmental Consequences

The following discussion describes the environmental consequences to grazing land and its relation to the significant issue of livestock grazing. The analysis considers the effects to grazing land in a landscape context and evaluates the alternatives in terms of the ability of the alternatives to contribute to grazing land health (e.g., sustainability, resilience, response to disturbance regimes, ability to maintain rangelands functionality relative to state and transition models).

Indirect Effects

Rangeland Vegetation Effects Common to all Three National Forests

Alternative A

The vegetation composition would be expected to maintain the current progress toward desired conditions and trends identified in the 1990 Forest Plans.

Current data tends to indicate that recovery trends have slowed, although the exact reasons for this are not known. Some sites, primarily foothills (especially where impacted by nonnative plant species) and certain high elevation sites where historic impacts have exceeded a threshold, would continue to remain in poor to fair range condition (approximately corresponds to the early to low mid-seral status and/or Phase D). In any case, assuming that approximate current permitted livestock levels and management would remain the same for Alternative A, it is likely that upland rangeland conditions would continue their improvement on most sites. In some instances this improving trend would be impacted, and could even be reversed by invasive species, or in the longer term, by climate change. Conifer or other woody vegetation encroachment and over-story canopy cover would be expected to continue at a relatively unchanged pace. This will continue to impact grazing land health on those sites in or adjacent to the woody vegetation. As the Rescission Act schedule for allotment environmental analyses concludes at the end of the life of these Plans, vegetation and soil condition and trends will have been verified and prescriptions applied where needed for improvements to meet desired conditions.

For Alternative A the amount of rangeland in Phases A through D identified in Table 87 on page 159 is expected to remain unchanged, since recovery of native species on rangeland appears to have stabilized during the last 10 years (Countryman and Swanson, planning record). Rangelands that are currently in Phase C as a result of livestock grazing could show passive recovery if permitted livestock numbers are reduced. Rangelands that are currently in Phase D are not expected to change as a result of decreased livestock numbers.

The description of the PACFISH and INFISH riparian management objectives as described in Appendix A, Volume 4 would be considered to be the desired conditions. These riparian

conditions would remain similar to the existing conditions due to the goal statement (desired condition) from the 1990 forest plans that states that range ecosystems should be managed to ensure that the basic needs of the forage and soil resource are met. Forage production, above that needed for maintenance or improvement of the basic resources, would be made available to wildlife and permitted livestock.

Effects to rangeland vegetation from wildfire may require rest from livestock grazing for a period of time to allow regrowth, depending on the severity of the fire.

Alternative B

The vegetation composition would be expected to maintain the desired condition and trend while meeting standards and guidelines.

Current rangeland condition (health and sustainability) would continue to improve across the landscape as it has in the recent past, but possibly at a slower rate. Recovery would be due in part to using the best available science for continued management of lands where livestock grazing is permitted. Some sites, primarily foothills (especially where impacted by nonnative plant species) and certain high elevation sites where historic impacts exceeded a threshold, would continue to remain in Phases C and D. Due to budget constraints, as well as feasibility, restoration efforts would continue to be limited. As the Rescission Act schedule for allotment environmental analyses concludes at the end of the life of these Plans, vegetation and soil condition and trends will have been verified and prescriptions applied where needed for improvements to meet desired conditions.

Implementation of Alternative B would continue the trend towards improved rangeland vegetation conditions at about the same rate as Alternative A. As with all alternatives, some areas would remain in Phase D.

Riparian condition is in an upward trend across the Blue Mountains (Archer 2009, Meredith et al. 2012). The maximum allowable utilization for riparian vegetation would be 40 percent, slightly lower than the 40 to 50 percent that Alternative A would allow. The riparian vegetation upward trend would continue for all three National Forests.

Alternative B proposes that grazing after wildland fire should be managed so as not to cause a trend away from the key species desired condition. This may include growing season deferment for one or more years following wildland fire depending on the severity of the fire.

Alternative C

The vegetative composition would be expected to improve the desired condition in the riparian areas with the “unsuitable” for livestock grazing designation.

Currently the allowable utilization of available forage on suitable upland grasslands is 50 to 55 percent. Alternative C would reduce this utilization to 30 percent. This would be a moderate to high change substantially decreasing the utilization in both riparian and uplands.

The effect of this alternative on rangelands would generally be minimal to moderate, given that the available information (range transect data, current vegetation survey plots, PACFISH/INFISH biological opinion monitoring) indicates that current grazing management at the scale of the Blue Mountains has led to an improvement of both upland and riparian conditions. Some of these areas may show a fairly rapid recovery initially that would slow over time.

Implementation of Alternative C would continue the trend towards improved rangeland vegetation conditions. Sites where livestock grazing is controlling the transition to an alternate phase would likely transition as a result of the decrease in suitable grazing land in this alternative. As with all alternatives, some areas would remain in Phase D. As the Rescission Act schedule for allotment environmental analyses concludes at the end of the life of these Plans, vegetation and soil condition and trends will have been verified and prescriptions applied where needed for improvements to meet desired conditions.

Riparian areas and subwatersheds with habitat for listed fish species would be unsuitable for permitted livestock grazing. This loss of area for permitted livestock and the change to riparian vegetation utilization to 10 percent would be expected to result in the most rapid short-term recovery of riparian areas and wetlands. Allowable forage utilization of 10 percent for incidental grazing is proposed since the riparian areas are still the main source of water and/or livestock movement, and will not be fenced out. Total livestock removal would be likely to benefit very specific riparian areas that may not be recovering as fast due to livestock grazing. Management Area 4B, Riparian Management Areas, is considered unsuitable for livestock grazing and would remove riparian acres from the suitable land base.

Alternative C proposes that grazing after wildland fire should be deferred until vegetation recovers to a condition where grazing will not cause the percent composition of native species to be reduced (cause a likely downward trend in key species). This is expected to be a minimum of 5 years, but could be up to 10 years depending on the extent and severity of the fire and other factors.

Alternative D

The vegetative composition would be expected to maintain the desired condition while meeting standards and guidelines.

Currently the allowable utilization of available forage on suitable grasslands is 50 to 55 percent. Alternative D would reduce this utilization to 40 to 50 percent. This would be a modest change with a limited effect since utilization in the uplands does not exceed 35 to 40 percent in most active allotments.

Implementation of Alternative D would continue the trend towards improved rangeland vegetation conditions. Additional Animal Unit Months for cattle and narrower riparian management areas may slow recovery at a site specific scale. As with all alternatives, some areas would remain in Phase D. As the Rescission Act schedule for allotment environmental analyses concludes at the end of the life of these Plans, vegetation and soil condition and trends will have been verified and prescriptions applied where needed for improvements to meet desired conditions.

There could be an increase in riparian acres affected by livestock grazing, but the allowable riparian vegetation utilization would be the same as for Alternative B. However, riparian management areas (MA 4B) would be narrower than for the other alternatives (100 feet on either side of a fish-bearing stream compared to 300 feet for all other alternatives; see details in Appendix A). While the standards and guidelines that apply to MA 4B for all other alternatives apply to this alternative as well, the number of acres in this management area would be applied to a smaller area, which could lead to some impacts in the riparian zone (such as locating new livestock handling facilities, which should be placed outside of MA 4B (RMA-RNG-1)).

Effects to rangeland vegetation from wildfire may require rest from livestock grazing for a period of time to allow regrowth, depending on the severity of the fire.

Alternatives E and F

The vegetative composition would be expected to maintain the desired condition and trend while meeting standards and guidelines.

Currently the allowable utilization of available forage on suitable grasslands is 50 to 55 percent. Alternatives E and F would reduce this utilization to 35 to 45 percent. This would be a modest change with a limited effect since utilization in the uplands does not exceed 35 to 40 percent in most active allotments.

Improvement and maintenance of rangeland health, sustainability, and resilience would also remain approximately the same.

Implementation of Alternatives E and F would continue the trend towards improved rangeland vegetation conditions. Slightly more restrictive utilization guidelines in Alternatives E and F may result in slightly less forage utilization by permitted livestock than Alternative A. As with all alternatives, some areas would remain in Phase D. As the Rescission Act schedule for allotment environmental analyses concludes at the end of the life of these Plans, vegetation and soil condition and trends will have been verified and prescriptions applied where needed for improvements to meet desired conditions.

Riparian vegetation is in an upward trend across the Blue Mountains (Archer 2009, Meredith et al. 2012). The maximum allowable utilization for riparian vegetation for these alternatives would be 40 percent, slightly less than the 40 to 50 percent that would be allowed for Alternative A. The riparian vegetation upward trend would continue for all three National Forests.

Alternatives E and F propose that grazing after wildland fire should be managed so as not to cause a trend away from the key species desired condition. This may include growing season deferment for one or more years following wildland fire, depending on the severity of the fire.

Alternatives E-Modified and E-Modified Departure

The vegetative composition would be expected to maintain the desired condition and upward trend, with activities meeting standards and guidelines, especially for the Wallowa-Whitman National Forest with the Invasive Plant Environmental Impact Statement and Record of Decision of 2016, which authorizes a greater area of herbicide use to reduce competition with native plants.

Currently under Alternative A, the allowable utilization of forage on suitable uplands varies from 30 to 60 percent, depending on the satisfactory or unsatisfactory condition of the site. Allowable shrub use varies from 25 to 50 percent. Alternatives E-Modified and E-Modified Departure would reduce the upland utilization to 30 to 50 percent depending on departure from the desired condition and type of grazing system. Allowable shrub use would not exceed 40 percent. This would be a modest change with a limited effect since utilization in the uplands does not exceed 35 to 40 percent in most active allotments.

Additionally, both alternatives include an objective designed to improve a portion of rangeland in Phase C or D to Phase A or B for all three National Forests. These two alternatives also incorporate additional guidance within the greater sage-grouse habitat that was derived from the Forest Service and BLM's "Idaho and Southwestern Montana Greater Sage-grouse Land Use Plan" and the BLM's "Oregon Greater Sage-grouse Resource Management Plan." There are

guidelines for fence construction within greater sage grouse habitat, livestock turnout, and forage utilization.

Improvement and maintenance of rangeland health, sustainability, and resilience would also remain the same, until the allotment environmental analyses are completed verifying vegetation and soil condition and trends and prescribing specific actions for improvement. These Rescission Act schedule environmental analyses should conclude within the life of these Plans.

Implementation of Alternatives E-Modified and E-Modified Departure would continue the trend towards improved rangeland vegetation conditions. Slightly more restrictive utilization guidelines in Alternatives E-Modified and E-Modified Departure may result in slightly less use by permitted livestock than Alternative A. As with all alternatives, some areas would remain in Phase D without active restoration.

Riparian vegetation is in an upward trend across the Blue Mountains (Archer 2009, 2011). The maximum allowable utilization for riparian vegetation for these alternatives would be 45 percent, slightly less than the 30 to 50 percent that would be allowed for Alternative A. The riparian vegetation upward trend would continue for all national forests.

Both Alternative E-Modified and E-Modified Departure incorporate the 2018 Blue Mountains Aquatic and Riparian Conservation Strategy grazing guideline for riparian grazing management, as well as all of the other 2018 Blue Mountains ARCS standards and guidelines for grazing. This guideline focuses on the watershed condition framework assessment condition classes, and ratings for those indicators that livestock may influence. The purpose of this guideline is to manage livestock grazing to help attain and maintain aquatic and riparian desired conditions over time. Specifically, it is intended to maintain or improve vegetative and stream conditions, help ensure the viability of aquatic species, provide important contributions to the recovery of federally listed species, and facilitate attainment of State water quality standards.

Alternatives E-Modified and E-Modified Departure propose that grazing after wildland fire should be managed so as not to cause a trend away from the key species desired condition. This may include growing season deferment for one or more years following wildland fire.

Livestock Grazing – Environmental Consequences

The alternatives vary in regard to several parameters affecting livestock grazing including acres suitable for grazing, animal unit months, riparian management, proximity of domestic sheep to bighorn sheep, and post-fire guidance.

Indirect Effects

Suitability and Animal Unit Months

Malheur National Forest

Alternatives E-Modified and E-Modified Departure would make available the most acres suitable for permitted cattle grazing in active and vacant allotments and the most cattle and sheep animal unit months. Alternative A would make available the most acres suitable for permitted sheep grazing in active allotments, although it is not significantly greater than the acres that would be suitable for Alternatives B, D, E, E-Modified, E-Modified Departure, and F.

Table 94 displays the comparison of the key indicators used to evaluate the livestock grazing and grazing land vegetation issue by alternative for the Malheur National Forest.

Table 94. Malheur National Forest livestock grazing indicators for each alternative

Indicator	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alts. E-Mod. and E-Mod. Dep.	Alt. F
Acres suitable for permitted cattle grazing in active allotments	1,197,000	1,225,000	620,000	1,216,000	1,197,000	1,262,700	1,197,000
Acres suitable for permitted cattle grazing in vacant allotments	0	0	0	0	0	54,800	0
Acres suitable for permitted sheep grazing in active allotments	102,000	101,000	55,000	101,000	101,000	101,000	101,000
Permitted animal unit months (cattle)	117,000	120,000	61,000	119,000	117,000	126,000	117,000
Permitted animal unit months (sheep)	6,500	6,500	1,200	6,500	6,500	7,200	6,500

Umatilla National Forest

Alternative B would make available the most acres suitable for permitted cattle grazing in active allotments, and Alternatives E-Modified and E-Modified Departure would make available the most cattle animal unit months. Alternatives A, D, E, E-Modified, E-Modified Departure, and F would make available an equal number of acres suitable for cattle grazing, or about 96 percent of the acres that would be suitable for Alternative B. Alternatives A, D, E, and F would make available an equal number of cattle animal unit months, or about 97 percent of the cattle animal unit months that would be available for Alternative B. Alternative C would make available approximately one-tenth as many suitable acres and approximately 10 percent of the cattle animal unit months as Alternative B.

Alternative A would make available the most acres suitable for permitted sheep grazing, but Alternatives E-Modified and E-Modified Departure would make available the most sheep animal unit months. Of the remaining alternatives, Alternatives D, E, E-Modified, E-Modified Departure, and F would make available the most acres suitable for sheep grazing along with Alternative A making available the second highest number of sheep animal unit months. Alternative B would make available less than half as many suitable acres as Alternative A and about 59 percent of the sheep animal unit months that would be available for Alternative A. Alternative C would make available about 22 percent of the suitable acres and about 15 percent of the sheep animal unit months as Alternative A.

Table 95 displays the comparison of the key indicators used to evaluate the livestock grazing and grazing land vegetation issue by alternative for the Umatilla National Forest.

Table 95. Umatilla National Forest livestock grazing indicators for each alternative

Indicator	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alts. E-Mod. and E-Mod. Dep.	Alt. F
Acres suitable for permitted cattle grazing in active allotments	284,000	298,000	30,000	284,000	284,000	284,000	284,000
Acres suitable for permitted sheep grazing in active allotments	60,000	28,000	13,000	42,000	42,000	42,000	42,000
Permitted animal unit months (cattle)	30,000	31,000	3,000	30,000	30,000	39,000	30,000
Permitted animal unit months (sheep)	7,800	4,600	1,200	5,800	5,800	10,200	5,800

Wallowa-Whitman National Forest

Alternatives E-Modified and E-Modified Departure would make available the most acres suitable for permitted cattle grazing in active and vacant allotments, and the most cattle animal unit months. Alternatives A, D, E, E-Modified, E-Modified Departure, and F would make available the most acres suitable for permitted sheep grazing, and Alternatives A, D, E-Modified and E-Modified Departure would make available the most sheep animal unit months. The remaining alternatives would make available equal sheep animal unit months.

Table 96 displays the comparison of the key indicators used to evaluate the livestock grazing and grazing land vegetation issue by alternative for the Wallowa-Whitman National Forest.

Table 96. Wallowa-Whitman National Forest livestock grazing indicators for each alternative

Indicator	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alts. E-Mod. and E-Mod. Dep.	Alt. F
Acres suitable for permitted cattle grazing in active allotments	408,000	393,000	135,000	422,000	408,000	466,000	408,000
Acres suitable for permitted cattle grazing in vacant allotments	0	0	0	0	0	61,100	0
Acres suitable for permitted sheep grazing in active allotments	25,000	22,000	22,000	25,000	25,000	25,000	25,000
Permitted animal unit months (cattle)	77,000	74,000	26,000	80,000	77,000	107,500	77,000
Permitted animal unit months (sheep)	4,500	3,500	3,500	4,500	3,500	4,500	3,500

Amount and Percent of National Forest System land in Active Grazing Allotments

Alternative A

No change would be expected in the amount and percentage of National Forest System land in active grazing allotments.

Alternative B

Completing the Rescission Act schedule for range allotment management plan environmental analysis would potentially increase acres and percent of suitable grazing land if vacant allotments become active. This analysis and subsequent decision to convert a vacant allotment to active would be done at the project level.

Alternative C

Completing the Rescission Act schedule for range allotment management plan environmental analysis would potentially increase acres and percent of suitable grazing land if vacant allotments become active. This analysis and subsequent decision to convert a vacant allotment to active would be done at the project level.

Alternative D

This alternative includes some vacant allotments in the suitable land base. Completing the Rescission Act schedule for range allotment management plan environmental analysis would potentially alter acres and percent of suitable grazing land if vacant allotments or portions of the vacant allotments are determined to be unsuitable. This analysis and subsequent decision regarding actual suitable acres of the vacant allotments would be done at the project level.

Alternatives E and F

Completing the Rescission Act schedule for range allotment management plan environmental analysis would potentially increase acres and percent of suitable grazing land if vacant allotments become active. This analysis and subsequent decision to convert a vacant allotment to active would be done at the project level.

Alternatives E-Modified and E-Modified Departure

These alternatives would include all of the vacant allotments in the suitable land base. There would be increases in suitable acres for livestock grazing and the percent of National Forest System land in active grazing for the Malheur and Wallowa-Whitman, but not for the Umatilla since there are no vacant allotments. Completing the Rescission Act schedule for range allotment management plan environmental analysis would potentially alter acres and percent of suitable grazing land if vacant allotments or portions of the vacant allotments are determined to be unsuitable. This analysis and subsequent decision regarding actual suitable acres of the vacant allotments would be done at the project level.

Acres in Active Allotments Suitable and Capable For Grazing

Alternative A

No change would be expected in the acres of rangeland and grazable forestland suitable for cattle and sheep grazing.

This alternative would have a single standard:

1. Do not stock livestock allotments in bighorn sheep range with domestic sheep (Malheur National Forest)
2. Manage the conflict between bighorn sheep and domestic sheep in coordination with state wildlife agencies (Umatilla and Wallowa Whitman National Forests)

Alternative B

Suitable acres for sheep would be slightly reduced to minimize the risk of potential disease transmission from domestic sheep to bighorn sheep. Suitable acres for cattle would not be expected to change. Suitable acres for sheep would be slightly reduced to minimize the risk of potential disease transmission from domestic sheep to bighorn sheep. RNG 13 would be a guideline of trailing of domestic sheep or goats should not be authorized or allowed within 7 miles of bighorn sheep home ranges.

Alternative C

Suitable acres for cattle and sheep would be expected to decrease due to the riparian buffers being designated as unsuitable for livestock grazing. Suitable acres for sheep would decrease more than the other alternatives due to the institution of the bighorn sheep ram maximum foray distance buffer designation for unsuitable domestic sheep grazing.

RNG 13 would be a Standard of trailing of domestic sheep or goats should not be authorized or allowed within 7 miles of bighorn sheep home ranges.

Approximately 60 percent of currently active cattle grazing allotments would be unsuitable for livestock grazing. This suitability determination would be implemented through project level analysis and decisions. This would eventually result in a corresponding decrease in permitted animal unit months as displayed in Table 94 through Table 96.

Alternative D

This alternative would designate more acres as suitable for cattle because the riparian management areas would be the smallest. However, suitable acres for sheep would be slightly reduced to minimize the risk of potential disease transmission from domestic sheep to bighorn sheep.

RNG 13 would be a standard. “Trailing of domestic sheep or goats should not be authorized or allowed within 7 miles of bighorn sheep home ranges.”

Small increases in acres in active allotment status with a corresponding slight to moderate increase in permitted livestock numbers and animal unit months could occur. Actual modifications to management and stocking would be dependent on the outcome of project-level planning and decisions and would be based in part on budget levels that would allow for more intense management in specific situations, as well as for stocking of some vacant allotments. Overall, projected increases are relatively small and would not be expected to result in major effects.

Alternative E and F

Suitable acres would not change for cattle; however, suitable acres for sheep would be slightly reduced to minimize the risk of potential disease transmission from domestic sheep to bighorn sheep.

RNG 13 would be a standard. “Trailing of domestic sheep or goats should not be authorized or allowed within 7 miles of bighorn sheep home ranges.”

Overall, the permitted cattle animal unit months would remain approximately the same and any actual modifications to management and stocking would be dependent on the outcome of project-level planning and decisions.

Alternatives E-Modified and E-Modified Departure

Suitable acres would increase for cattle due to the inclusion of vacant allotments; however, suitable acres for sheep would remain the same as the current condition since environmental analysis has been completed for most of the sheep allotments and reductions have been made to minimize the risk of potential disease transmission from domestic sheep to bighorn sheep. Where environmental analysis has not been completed for sheep allotments, suitable acres may be reduced.

Several standards would be proposed to insure continued separation between bighorn and domestic sheep, including the trailing of domestic sheep or goats shall not be authorized where effective separation from bighorn sheep cannot be reasonably maintained.

Animal Unit Months for Cattle and Sheep

Alternative A

No change is expected in cattle and sheep animal unit months.

Alternative B

Animal unit months for sheep would be slightly reduced to minimize the risk of potential disease transmission from domestic sheep to bighorn sheep. Animal unit months for cattle would not be expected to change.

Alternative C

Animal unit months for cattle and sheep would be expected to decrease due to the riparian buffers being designated as unsuitable for livestock grazing. Sheep animal unit months would decrease more than the other alternatives due to the institution of the bighorn sheep ram maximum foray distance buffer designation for unsuitable domestic sheep grazing.

Alternative D

This alternative would designate more animal unit months for cattle because the riparian management areas would be the smallest. However, animal unit months for sheep would be slightly reduced to minimize the risk of potential disease transmission from domestic sheep to bighorn sheep.

This alternative would designate more acres as suitable for cattle because the riparian management areas would be the smallest. However, suitable acres for sheep would be slightly reduced to minimize the risk of potential disease transmission from domestic sheep to bighorn sheep.

Alternative E and F

Animal unit months would not change for cattle; however, animal unit months for sheep would be slightly reduced to minimize the risk of potential disease transmission from domestic sheep to bighorn sheep.

Suitable acres for sheep would be slightly reduced to minimize the risk of potential disease transmission from domestic sheep to bighorn sheep.

Alternatives E-Modified and E-Modified Departure

Animal unit months would increase for cattle; however, animal unit months for sheep would remain the same as the current condition for the Wallowa-Whitman and increase on the Malheur, and where environmental analysis that has been completed for the sheep allotments, including the risk of contact assessments, on the Umatilla.

Grazing after Wildfire

Alternative A

Alternative A would not include post-fire guidance for livestock grazing. Depending on fire intensity, grazing may be modified. Desired conditions for rangeland vegetation would guide management activities.

Alternative B

Alternative B would create a guideline that grazing after wildland fire should be managed so as not to cause a trend away from the key species desired condition. This may include growing season deferment for one or more years following wildland fire. Depending on the size and severity of the wildfire, this could affect one or more pastures, or the entire allotment in the short term. In the long term, forage vigor and quality may be improved.

Alternative C

Alternative C would create a standard that grazing after wildland fire shall be deferred until vegetation recovers to a condition where livestock grazing will not cause the percent composition of native species to be reduced (cause a likely downward trend in key species). This generally will be a minimum of 5 years, but could be up to 10 years depending on the extent and severity of the fire and other factors. This alternative would provide rangeland vegetation with the greatest opportunity to recover from wildland fire. Depending on the size and severity of the wildfire, this could affect one or more pastures, or the entire allotment. This may be a very negative impact or hardship on the permittee(s) if there are no available vacant allotments they could occupy during this extended rest period.

Alternative D

Alternative D would not include post-fire guidance for livestock grazing. Rangeland vegetation desired conditions would guide management activities.

Alternative E and F

Alternatives E and F would create a guideline that grazing after wildland fire should be managed so as not to cause a trend away from the key species desired condition. This may include growing season deferment for one or more years following wildland fire. Depending on the size and severity of the wildfire, this could affect one or more pastures, or the entire allotment in the short term. In the long term, forage vigor and quality may be improved.

Alternatives E-Modified and E-Modified Departure

Alternatives E-Modified and E-Modified Departure would create a guideline that grazing after wildland fire should be managed so as not to cause a trend away from the key species desired condition. This may include growing season deferment for one or more years following wildland fire. Depending on the size and severity of the wildfire, this could affect one or more pastures, or the entire allotment in the short term. In the long term, forage vigor and quality may be improved.

Cumulative Effects

The analysis area for cumulative effects includes all 14 counties of the Blue Mountains, including lands administered by other Federal agencies (BLM, BIA) Tribal lands, state lands, and private lands. Grazing lands throughout the project area have been and continue to be subject to a wide variety of impacts. Many ranchers depend on allotments administered by the Forest Service and Bureau of Land Management to provide a portion of their year-round grazing operations. As private land continues to be developed and property values continue to increase, the desirability and feasibility of some allotments used for livestock production could decline. The project area includes an accumulation of diverse and highly dynamic land with extensive site-specific characteristics that respond to each impact in a distinctive manner and within a unique and often unknown timeframe. It is essential to understand the legacy of historical impacts in order to make informed decisions on changes to rangeland management direction (as reflected within the alternatives). Additionally, understanding the historical impacts is important to consider in the context of attempting to maintain or achieve desired conditions. These impacts, taken together as past, present, and reasonably foreseeable future effects, are cumulative effects.

Wildland Fire

Fire is an intrinsic disturbance process in many rangeland ecosystems. Examples include:

- Aspen communities where fire is a key disturbance factor in regeneration and removal of conifer competition.
- Mountain big sagebrush communities where fire is a key disturbance factor in maintaining a mosaic of seral stages and age classes and in ensuring sustainability of an understory that can be overshadowed by sagebrush.

Other grazing lands are not necessarily dependent on fire as a key disturbance but have adapted to thrive in the presence of periodic fire or other disturbance, such as drought or insect infestations. Most grazing land grass/forb communities are adapted to periodic vegetative material removal and regeneration and tend to be most healthy in the presence of periodic fire and disturbance. Until about the mid-1900s, natural fire played its natural role. In general, this periodic natural fire maintained canopy covers within natural ranges; allowed for mosaics of plant communities, seral stages, and age classes; and helped to stimulate new growth of grasses and to keep them healthy and thriving. Since the mid-1900s, humans restricted the occurrence and spread of natural fire. This has had the effect of allowing an increase in conifer canopy and the encroachment of conifers, juniper, or sagebrush into open grasslands or shrublands thereby decreasing herbaceous cover and impacting those species which required open sunny conditions. As canopies closed, the understory herbaceous and shrubby vegetation was reduced or lost. This impacted forage quantity, quality, and availability for native ungulates, as well as for permitted livestock. With this loss, forage harvest was concentrated even more on the open grasslands, shrublands or on riparian areas and wetlands.

Fire exclusion has had a significant effect on grazing land vegetation and this effect is expected to continue into the future in areas where increased urbanization has made the use of fire and the potential for natural fire more difficult.

Conversely, the use of prescribed fire has also had effects on grazing lands. In some instances, fire was used to control shrub vegetation (e.g., sagebrush or juniper) without a clear understanding of how natural fire would have affected plant communities. In other instances, fire was overused and impacted plant community health and sustainability. Additionally, fire use inadvertently favored the spread of invasive species, such as cheatgrass. For the most part, prescribed fire has had minimal and mostly short-term effects to rangeland resources, such as soils, vegetation, wildlife, and recreational or visual quality.

It is critical to allow rest from livestock grazing for recovery of the vegetation following any high intensity wild fire or prescribed fire. Lower intensity or mosaic prescribed fire tends to stimulate vegetative growth and is normally considered to have a positive effect on rangeland vegetation.

Large Wild Ungulates

During the past century-and-a-half or so, there have been significant changes in both the species and the population of large wild ungulates, such as deer, elk, and wild horses. Some changes have been a result of human decisions designed to increase populations of deer and elk. At times these actions worked too well with the effect that the population exceeded grazing capacity with negative and lasting impacts to the vegetation (and sometimes to the soils) in certain geographic areas. This has been demonstrated through the use of upland exclosures.

In some cases, wild ungulate populations increased to occupy available habitat niches. Elk are a prime example in the Blue Mountains with few if any elk present in the early 1900s and increased populations currently. The effect of this could increase the grazing pressure on forage and browse plants, especially when the increased wild ungulate population is added to permitted livestock. In general, the initially rapid reduction in permitted livestock (early 1900s) followed by a slower but continuing reduction in both permitted numbers, seasons of use, and areas open to livestock grazing has offset the increased effects of large wild ungulate use. However, this is not the case everywhere and the dual use results in both historic and current impacts to soils and forage resources in some areas. It is expected that this situation will continue with relatively stable large wild ungulate populations (with natural fluctuations) and a slow decline in permitted livestock (or in the case of some of the alternatives, a rapid and significant decrease in permitted livestock).

Roads

Most road construction occurred during the past 40 to 50 years. The construction of roads in the uplands was done to access management areas for timber harvest and forested vegetation activities. For the most part, these roads have few direct effects on grazing lands, but there can be a number of indirect and cumulative effects. Specifically, roads tend to act as significant vectors for the invasion or spread of invasive species. This is discussed in more detail in the access section but for the grazing lands vegetation assessment purposes, invasive species tend to have a very long lasting impact on grazing lands health (especially on disturbance regimes and resilience/sustainability). The effect of invasive species dates to the early to mid-1900s. Effects include competition with native grasses and forbs for space, water, and nutrients. In the most extreme examples, certain invasive species can replace native plant communities and result in a transition to phase D that may not respond to reasonable restoration efforts. Invasive species can and have also impacted fire regimes with the greatest impacts occurring to upland shrub

communities (e.g., a cheatgrass infestation). However, upland roads have also altered water regimes to the extent that natural runoff is diverted or subsurface water flow is intercepted and then diverted. This can change local plant communities. In addition, it was common practice at one time to seed roads with nonnative species, such as smooth brome (*Bromus inermis*) or yellow blossom sweet clover (*Melilotus officialis*). These species have had an effect on native grazing lands vegetation, at times replacing native grasses and forbs on specific sites.

Recreation

Increases in wildland recreation use have often paralleled the development of roads with four-wheel or backcountry driving becoming a significant impact in some areas. For the most part, early to mid-1900s recreation was limited to hunting and camping mostly along riparian areas. More recently recreation has increased with very significant increases in backcountry driving. As recreation uses of all kinds have increased, so too have the conflicts between uses and activities, such as permitted livestock grazing, as well as with desired vegetative conditions. Increases in recreation activity tend to be associated with increases in soil erosion, importation and spread of invasive plants or animals, and damage to rangeland vegetation, as well as an increase in livestock management gates left open, water developments damaged, and livestock harassed with a resultant loss in management control and effectiveness. With increasing urbanization and a desire for recreation on national forests, it would be expected that conflicts and impacts would continue and possibly increase.

Private Lands and Open Space

Private lands within and associated with the Plan Area have historically been used for activities in conjunction with uses and activities on National Forest System lands. For example, all livestock grazing permits for the national forests are linked with private ranch lands through requirements for ownership of base property. In addition, most permit holders are dependent on national forest grazing permits to round out and make their overall operations economically viable. For a variety of reasons, public lands have seen a decline in the amount of forage authorized for use. This trend is anticipated to continue, although at a slower rate. Livestock operation costs are expected to continue rising and market prices will continue to fluctuate. This will result in economies of scale and some smaller operators may dispose of base properties due to financial reasons. In such cases allotments may be released and may or may not be incorporated into other allotments.

In general, National Forest System lands within the Plan Area can and are affected by management of the private lands. As ranches are sold and subdivided, there will continue to be a net loss of open space. Development of the private lands for home sites tends to increase impacts to the national forests for recreation, but there are also effects associated with loss of wildlife habitat and increases in invasive species infestation and spread. This has led to the relatively recent recognition of the importance of maintaining open space as an important component of wildlife habitat, maintenance of native biodiversity, and for social values offered by solitude. The open space offered by National Forest System lands becomes increasingly important, especially as private lands are developed for home sites.

Water Development and Uses

Scattered through the project area are various kinds of water developments, including reservoirs for irrigation water and recreation; diversions, normally for irrigation but also for urban uses; and developments for livestock, recreation, and so forth. The impacts of these developments are difficult to describe and quantify relative to grazing lands, but, in general, diversion of water from

one place to another tends to affect native vegetation and soils. Loss of water in one place can result in changes of vegetation to more xeric species while addition of water to other sites, such as along conveyance ditches, often results in increases in mesic vegetation and often in invasive species. The contrary also exists where water developments that were constructed for livestock use are now readily used and relied upon by wildlife, even to a greater extent than by livestock. Some of these developments have been in place for decades to a century or more, so the effects are well established. With increasing years of drought and listing of federally listed species, especially fish, it is likely that there will be additional water developments desired on the allotments in the future, especially with the increased need to keep livestock off streams with federally listed fish.

Forest Vegetation Management

Management of conifer vegetation over time has had important effects to grazing land vegetation. Historically, forested vegetation was manipulated by Native Americans through the use of fire to maintain a relatively open canopy. This often was based on maintaining ease of travel, as well as habitat for wildlife species used by the Native Americans for food and other needs. When Euro-Americans settled in the area, the most significant impacts would have been as a result of control of fire (e.g., increases in canopy cover with loss of understory herbaceous and shrubby vegetation or encroachment of conifers into rangelands). The early livestock management practices associated with heavy utilization and improper management resulted in a loss of fine fuels to carry fire and an increase in forested vegetation regeneration with no means of maintaining it at levels representative of the historic ranges. With early logging practices that tended to hi-grade mature timber (especially ponderosa pine and Douglas-fir), little thought was given to managing the residual forested vegetation or to reproduction for future forest health. The result again was a dramatic increase in canopy cover, encroachment into rangelands, and a general dramatic loss of herbaceous and woody understory species and forage production for both wildlife and livestock. More recently, forested vegetation management has moved to a longer-term focus of healthy forestlands, but there is a huge backlog of overstocked stands with little or highly altered understory herbaceous and shrubby vegetation. At the same time, a continuation of fire suppression practices has exacerbated this situation. The long-term effect of this is a reduction in understory vegetation relative to what likely occurred prior to the 1900s with a continuing loss of forage production and wildlife habitat. Wildlife and permitted livestock forage harvest is now and will continue to be more concentrated on true rangelands than under historic range.

Climate Change

Climate change, primarily through increases in temperatures and carbon dioxide, and changes in precipitation, likely will result in shifts in species composition and distributions of rangeland communities and thus also in forage production. Climate changes have resulted and will continue to result in earlier initiation of the growing season, longer growing season length, earlier plant senescence, mismatches between climate characteristics and plant phenology, and increased risk of drought and fire disturbance. In fact, rangeland systems in general may be an early indicator of climate change due to the dominance of grasses and forbs and, hence, their relatively higher sensitivity to annual climate variability compared to forestlands (Halofsky and Peterson 2017).

General increases in precipitation could result in expansion of woody species and shifts from grasslands to shrublands, or from grasslands and shrublands to woodlands and forests. Conversely, decreases in effective precipitation could cause declines in vegetation productivity and shifts from forests, woodlands, and shrublands to grasslands and deserts. Given enough water for growth, elevated carbon dioxide has the potential to increase rangeland plant productivity

through increases in water-use efficiency. Native cool season species are positively affected by higher carbon dioxide levels, but so are some nonnative invasive plant species, such as cheatgrass, red brome, and others (Chambers and Pellant 2008, Halofsky and Peterson 2017).

Some species have the potential to migrate upslope with increases in temperature. However, habitat fragmentation and barriers to migration may impede many species from migrating to more suitable habitats in the north. Some native rangeland species may be displaced where climate change favors invasive species (Halofsky and Peterson 2017).

Rangelands will likely be affected by increasing amounts of wildfire but may still have fewer disturbances than occurred either historically (e.g., natural fire, Native American fire, wild ungulate grazing) or through Euro-American activities. Ecosystem disturbances can accelerate both loss of native species and invasion of exotics (Sala et al. 2000).

Changes in rangeland composition, structure, and productivity could have consequences for livestock grazing, including changes to the annual timing of grazing (e.g., earlier on- and/or off-dates), and reduced overall AUMs where forage production declines.

Effects from the Alternatives – Although we know an ecosystem’s sensitivity to grazing pressure and threshold for degradation changes with bioclimatic setting, resulting in lower sustainability in very dry and very humid ecosystems (Asner et al. 2004), the future bioclimatic setting within the project area is highly uncertain. It is very likely that as future average temperatures increase, snow pack will be reduced, snow melt, run-off and peak flows will occur earlier in the year (Ryan and Archer 2008). In addition, with increased atmospheric carbon, primary production is expected to increase particularly on semi-arid rangelands (Derner and Schuman 2007).

Issue 4: Old Forest

This section describes the affected environment and possible environmental consequences of the alternatives related to the old forest significant issue. Many commenters suggested an active approach to accelerate the development of old forest structure while reducing the risk of loss from insects, disease and wildfire. Other people prefer the use of non-mechanical (other than timber harvesting) means to restore old forests, and also support the designation of old forest reserves where no significant timber harvest is allowed. The “Timber and Forest Products” and “Forest Vegetation” sections of this document also discuss the existing condition of old forest in the Blue Mountains and the effects of the alternatives on the amount of old forest over time. This section summarizes that information and describes the management approaches for old forest by alternative. The “Terrestrial Wildlife Species Diversity and Viability” section discusses the importance of old forest as habitat and the effects of the alternatives on wildlife species that depend on old forest.

Changes Made Between the Draft and Final Environmental Impact Statements

Aside from the global changes throughout this environmental impact statement described in the Preface to this document, the following changes were made specifically to this section:

Changes to the Descriptions of Key Indicators: The data presented in the draft environmental impact statement representing the second key indicator metric was specifically limited to monitoring timber harvesting treatments. It did not include any other “vegetation treatments” as

the description in the draft implied. The description of the key indicator has been changed to clarify this.

The descriptions of the third and fourth indicators that were presented within the “Environmental Consequences” section in the draft environmental impact statement were revised and clarified to be consistent with the way the key indicators are described elsewhere in the document.

Expanded Discussion of the General Effects Expected from Different Management Approaches: We received various comments on the draft plan and environmental impact statement either advocating for, or criticizing different approaches to old forest conservation and management that were considered in the alternatives. In response, additional discussion of these different strategies was added to the “Environmental Consequences” section.

Old Forest – Affected Environment

The Blue Mountains were historically well known for vast expanses of old forest, particularly the iconic old “park-like” ponderosa pine of the dry upland forest. The natural range of variability analysis completed for this environmental impact statement also shows that prior to the influences of European settlement, the Blue Mountains were dominated by large areas of old forest, particularly within the dry upland potential vegetation group.

Although simple impressions of old forests, or “old-growth” forests, as large trees in an undisturbed landscape may exist within the minds of many people, answering the basic question, “What is old forest?” is complex (Egan 2007). Old forest has been defined many times and in many different ways. It is difficult to write a definition of old forest that will be applicable to all forest types (Kaufmann et al. 2007). However, in October of 1989 the Chief of the Forest Service directed all Regions of the agency to develop ecologically based old-growth definitions for the major forest cover types. Consequently, interim old-growth definitions were introduced by the Pacific Northwest Region of the Forest Service in the 1990s (USDA Forest Service 1993x). These structure based definitions incorporate minimum numbers of trees per acre of qualifying ages ranging from 150 to 200 years as well as minimum sizes of 21 to 31 inches for several forest types common to this area. Smaller size thresholds apply to other cover types like lodgepole pine.

This analysis followed the old-growth definitions contained in the Pacific Northwest Region’s interim old-growth definitions in regards to characterizing old forest structural stages. The expression “old forest” is regularly used synonymously throughout this analysis instead of the term “old growth.” Old growth is a term that has become generally associated with the kind of forests that develop through natural succession in the absence of large-scale disturbance over long periods of time. Some old forest types of the Blue Mountains have historically developed in this manner, but use of this term in the context of eastern Oregon and Washington can create confusion because it reinforces the misconception that all old forests behave and develop in the same manner. Much of the Blue Mountains forests are characterized by low- and mixed-severity fire regimes (Stine et al. 2014; Hessburg et al. 2016). Old forest structures that develop under these conditions have evolved more in response to frequent disturbance than as a result of successional processes and the absence of disturbance. The term old forest is considered more inclusive of the general concept of a late stage of stand structural development mainly distinguished from younger forest as being characterized by an abundance of large and old trees, regardless of whether it developed from lack of disturbance or as an adaptation to frequent disturbance.

It is also important to note that old forest does not refer to an individual old tree, or even a scattering of old trees. It is a late stage of forest stand development that evolves over a relatively long period of time, and it is characterized by specific structural attributes. While old forest is mainly distinguished from younger growth by having an abundance of trees that are truly old and large (both for the species and site conditions), other characteristics include variation in tree sizes and spacing, high accumulations of large-size dead standing and fallen trees, decadence in the form of broken or deformed tops or boles and root decay, canopy gaps, and understory patchiness (USDA Forest Service 1993x).

Because many of the old dry and mixed conifer upland forests naturally develop through time in response to frequent disturbances, compositionally, many old forests of the Blue Mountains may be expected to be made up of predominantly fire-resistant, shade-intolerant species that are often considered “early” seral trees (Spies 2004). However, in other cold and moist upland forests, the absence of disturbance over long periods of time allows these early seral species to be gradually replaced and the resulting old forest stands are typically dominated by shade-tolerant species (Oliver & Larson 1990). Similarly, depending largely on the natural disturbance regime, old forest may occur in a single-story stage, called “old forest single-storied,” or as a multi-storied stage, called “old forest multi-storied” (Stine et al. 2014). Rates of change in composition and structure within old forests are typically slow, relative to younger forests. Different stages or classes of old forest are recognizable in many forest types.

Old forest is not necessarily virgin or primeval, and old forests have developed following human disturbances, including timber harvest (Kolb 2007). Many believe old forests and their associated structural characteristics can be maintained or enhanced over time with properly designed harvesting (Burton et al. 1999; Bragg 2004; Bauhus et al. 2009). However, there is controversy and debate about whether old forests can be partially harvested without compromising their distinctive values (Hilbert and Wiensczyk 2007). More discussion about the use of harvesting and different silvicultural treatments as management tools can be found in the Ecological Resilience environmental consequences section.

A wide spectrum of social and ecological values are associated with old forests as well as individual large old trees. Old forests are some of the most ecologically and socially valuable structural stages in the Pacific Northwest (Spies and Duncan 2009). Old forests of the Blue Mountains are expected to provide a myriad of ecosystem services. Various groups find old forests aesthetically pleasing, ecologically important, economically valuable as a sustainable timber resource, and/or necessary for a landscape that is healthy and resilient to natural disturbances. Old forests and large old trees are also an important component of cultural identity for many groups of people.

Several wildlife species require the structural complexity typical of mature and old forests for habitat, and the presence of large old trees within a stand can make a big difference for wildlife habitat values in both old and young forests (Stine et. al. 2014). Widely distributed large, old trees provide a critical backbone, particularly to dry and moist upland forests (Hessburg et.al. 2016). Old trees, especially large old trees, found both within old forest stands and as scattered individuals are acknowledged to have great importance as ecological keystones. These trees are distinct from their younger versions in terms of ecological function. They have often developed physiological and structural features which make them extremely valuable in terms of wildlife habitat, fire and drought resistance and as genetic resources (Franklin & Johnson 2012).

As Hilbert and Wiensczyk (2007) point out, it is also important to recognize that other perspectives view old forest more in terms of its potential economic value. From this point of view, old forests and the largest, oldest trees within a stand would tend to be given harvesting priority because they:

- contain the greatest volume of valuable commercial timber;
- are considered to be at greater risk of deterioration through decay fungi or insect infestation;
- utilize timber production land that could potentially be occupied with more productive, younger stands.

While timber harvesting on the National Forest system lands is not revenue driven, but is done primarily to meet land management objectives, the continued economic viability of the Forest Service's private sector partners is part of what enables this work to be performed. As long as it supports other land management objectives, harvesting a higher proportion of larger trees, even only one or two large trees per acre can significantly improve the economic viability of a harvest-based restoration treatment. Some have also pointed out that carefully designed partial harvesting within old forests or harvesting mature and larger trees can also facilitate an increased scale of restoration work in other parts of the forest by providing timber sale receipts which can, in some cases, be used to offset the cost of treating less commercially viable stands nearby (Lynch 2001; Franklin et al. 2013).

Existing Condition

The relatively rapid decline of old forest as well as larger, older individual trees over the last century is an issue of concern across the globe (Lindenmeyer 2014). Within the inland northwest, regional landscape assessments over the past 20 years have related profound declines in the amount of old forests and large old trees (Hessburg and Agee 2003; Hessburg et al. 2005; Stine et al. 2014; Franklin & Johnson 2012; Hessburg et al. 2016). As shown in Table 97, compared to estimates of historical conditions, there has been a net loss of certain old forest structural stages within all three National Forests of the Blue Mountains, as well as disproportionate increases within some other old forest stages. Across all three National Forests of the Blue Mountains, the old forest single-story stage of the dry upland forest PVG has been greatly reduced from historical levels.

From its beginning, forest management of the National Forests emphasized what were perceived as efficient and productive forests capable of meeting the nation's demands into the future. The emerging discipline of American forestry in the early 20th century held that inferior diseased and decadent trees needed to be removed and replaced with young, healthy, rapidly growing trees. Generally, this meant replacing many stands, particularly within the dry upland forest, that were characterized by slower growing, old trees, with young, faster growing stands. As harvest of the largest old trees within the dry upland forest continued over decades, areas of old forest and their associated large old trees declined dramatically throughout the Blue Mountains national forests. The extent of the dry upland forest existing today in the old forest single-story structural stage ranges only from 1 to 4 percent versus a natural historical condition that is estimated to have been between 40 to 65 percent.

This is the most striking area of departure from natural conditions in terms of old forest structure. The total amount of old forest within the moist and cold upland forest potential vegetation groups is much closer to being within the range of what occurred historically on the landscape. However,

there have been pronounced shifts from single-storied to multi-storied conditions in many of these areas. The Malheur National Forest in particular has a large overrepresentation of moist upland forest in the old, multi-storied condition. The other two national forests are moderately overrepresented in this stage. The Umatilla National Forest is distinct from the other two National Forests as it contains an uncharacteristic excess of both the single-storied and multi-storied stages of its old moist upland forest structure.

Within all three National Forests, the current proportion of the moist and cold upland forest potential vegetation groups existing in old forest stages is generally closer to the historical range of variation than the dry upland forest potential vegetation group (see the following table).

Table 97. Current old forest structural stages (as a percent of forest potential vegetation groups) compared to the historical range of variability

Potential Vegetation Group and Structure	Historical Range of Variability	Malheur Existing Condition	Umatilla Existing Condition	Wallowa-Whitman Existing Condition
Cold old forest single story	5 – 20%	1%	0%	1%
Cold old forest multi-story	10 – 25%	20%	30%	34%
Dry old forest single story	40 – 65%	3%	4%	1%
Dry old forest multi-story	1 – 15%	20%	8%	14%
Moist old forest single story	10 – 20%	5%	23%	1%
Moist old forest multi-story	15 – 20%	47%	32%	25%
All vegetation groups old forest single story & old forest multi-story	not applicable	25%	30%	32%
All vegetation groups old forest single story & old forest multi-story (acres)	not applicable	365,000 acres	345,000 acres	444,000 acres

The percent of the dry upland forest potential vegetation group now in the old forest single-story structural stage is currently far below the levels that occurred historically. This level of departure is largely due to a combination of past timber harvesting practices and the interruption of the natural historical fire regime that would have normally maintained large areas of dry upland forest in the old, single-storied condition (see the “Ecological Resilience,” “Forest Vegetation” and “Wildland Fire” sections for more detail on these concepts).

Current Old Forest Management Direction Applicable to all three National Forests

Much of the current management direction relevant to old forests and large trees within all three National Forests comes from the Interim Management Direction Establishing Riparian, Ecosystem, and Wildlife Standards for Timber Sales (known as the “Eastside Screens”). This management direction was added to the 1990 forest plans by amendment in 1995. The Eastside Screens direction uses the term “late and old structure” to refer both single-storied and multi-storied old forest (see Appendix A for details on the content of the Eastside Screens Forest Plan amendment). In the forest plan revision analysis, what the Eastside Screens direction called late and old structure is now referred to as “old forest.”

The Eastside Screens direction was meant to be temporary guidance, partially designed to defer most harvesting of old forest until development of more comprehensive final management direction could be completed. For a variety of reasons, the forthcoming final direction did not become available. As a result, the Eastside Screens direction has continued to require the three

National Forests to compare existing conditions to estimates of historical levels of old forest prior to implementing most timber sales. If the amount of old forest in the landscape is found to be below the historical range of variation, the standard prohibits most timber harvesting within old forest stands, and also prohibits the harvest of any live tree greater than 21 inches diameter. The Eastside Screens management direction does not address or recognize designated old forest management areas, but applies wherever old forest occurs on the landscape.

Many stages of old forest are currently underrepresented on the landscape. The Eastside Screens interim management direction related to old forest has effectively resulted in the imposition of a diameter cap requiring the retention of most all live trees greater than 21 inches diameter at breast height, and a general prohibition on using timber harvesting within old forest stands, regardless of what management allocation they may currently exist in. During the 20-plus years since this direction was adopted, new perspectives and practical experience in forest restoration have contributed to the growing recognition that there is a need for more flexible strategies to allow forest managers to better integrate old forest conservation goals with other land management objectives (Brown 2012; Franklin & Johnson 2012; Franklin et al. 2013; Spies et al. 2006).

In addition to the overarching management direction from the Eastside Screens, the forest plans for each of the three National Forests also contain direction specific to old forest stands.

Existing Management Direction Specific to the Malheur National Forest:

The Malheur Forest Plan (1990) describes old growth (management area 13) as composed of mature/over mature sawtimber (150 years old or older), which provides habitat for wildlife species dependent on mature/over mature forest conditions, provides for ecosystem diversity, and provides for the preservation of aesthetic qualities.

Existing Goal: Provide “suitable” habitat for old growth dependent wildlife species, ecosystem diversity, and preservation of aesthetic qualities.

Current activity restrictions within Management Area 13:

- Identified as unsuitable for timber production management
- Motor vehicle use is restricted to open roads and trails
- New road construction should avoid old growth stands

Existing Management Direction Specific to the Umatilla National Forest:

Under current management direction, the Umatilla’s old forest is allocated to two management areas: Dedicated Old Growth and Managed Old Growth. The goal of dedicated old growth is to provide and protect sufficient suitable habitat for wildlife species dependent upon mature and/or over-mature forest stands and to promote a diversity of vegetative conditions for such species. The goal of managed old growth is to provide and protect sufficient suitable habitat for wildlife species dependent upon mature and over mature lodgepole pine forest stands and to promote a diversity of vegetative conditions for such species. Fuels treatments are permitted to maintain or enhance old growth habitat characteristics or reduce the potential for a large number of acres burned or high severity burns.

Current activity restrictions include:

- Motor vehicle use is restricted to open roads and trails
- New road construction should avoid old growth stands where feasible and practical

- Dedicated old growth: Timber production and harvest activities are not permitted
- Managed old growth: Timber harvest activities are permitted for the purpose of enhancing wildlife habitat (subject to the Eastside Screens direction)

Existing Management Direction Specific to the Wallowa-Whitman National Forest:

Under current management direction, a management area (MA 15) is allocated for the preservation of old forest ("old growth" in the current forest plan). It is intended to maintain habitat diversity, preserve aesthetic values, and to provide old-growth habitat for wildlife. Although the forest plan allocates 36,750 acres to this management area, maps of the allocations were not finalized at the time the plan was signed and later mapping of this allocation showed that it includes 60,285 acres.

Current activity restrictions within MA 15:

- Unsuitable for timber production management
- Timber harvest, including salvage, may occur (subject to the Eastside Screens direction)
- New road construction should avoid old growth

Old Growth Management Areas

All three National Forests currently have management allocations for old forest as displayed in Table 98. Only a limited amount of the Old Forest Management Areas currently contain actual old forest structural stage. Some stands were misclassified at the outset, and others have since transitioned into other structural stages.

Table 98. Old forest structure within 1990 forest plans designated old forest management areas

National Forest	Acres in Old Forest Management Areas	Actual Old Forest Structure within Old Forest Management Areas*
Malheur	84,232	33,000 acres (39%)
Umatilla	44,277	13,000 acres (22%)
Wallowa-Whitman	60,285	21,000 acres (35%)

* Based on existing vegetation layer structural stage classifications.

Old Forest – Environmental Consequences

Old forest key indicators include:

- Acres of old forest within management area allocations allowing limited or no management activity
- Acres of timber harvesting within old forest stands.
- Percent of old forest (all potential vegetation groups) at year 50
- Percent of dry upland forest potential vegetation group in old forest single-story at year 50

To estimate the potential effects on old forest resulting from management, disturbances and natural succession over time, the Vegetation Development Dynamics Tool model (ESSA Technologies Ltd. 2007) was used. The tool provided a modeling framework for simultaneously examining the effects of succession, various disturbance agents and management actions on old forest vegetation over long periods of time. The interaction of these factors can be quite complex and sometimes counterintuitive, but projecting these changes and incorporating how they interact

with one another is a very important part of a landscape scale analysis. Additional information about Vegetation Development Dynamics Tool modeling can be found in the “Forest Vegetation” section of this chapter.

Across all alternatives, the objectives and effects of silvicultural treatments modeled as occurring within old forest stands were assumed to be constrained by the individual design elements below, as well as with the shared desired conditions for old forest structure, which indicate pervasive needs to either increase or maintain many old forest structural stages. Simulated management of old forest was also guided by the desired conditions for other structural and functional attributes, such as stand density, species composition, fire regime condition class, insect and disease susceptibility and landscape patterns.

Because the dry upland forest is the dominant potential vegetation group across the Blue Mountains, and also the potential vegetation group with the greatest level of departure in terms of desired old forest structure classes, the majority of old forest treatments were modeled to occur within the dry upland forest potential vegetation group. However, some treatments were also modeled as being applied within the moist and cold upland forest potential vegetation groups.

Design Elements Specific to Alternative A

The management direction and treatment assumptions specific to Alternative A were consistent with the description of current management direction which is detailed above. Alternative A would continue to follow current direction from the Eastside Screens Forest Plan amendment and the individual forest plans.

Design Elements Specific to Alternative B

Alternative B would not include a specific land management area allocation for old forest. Old forest stands would not be included as lands considered suitable for timber production and timber volume harvested from them would not be chargeable volume contributing toward the allowable sale quantity. Alternative B would contain a guideline that would prohibit new road and trail construction within old forest.

Alternative B would include a guideline related to the management of individual large diameter trees. This guideline would require the retention of live trees 21 inches diameter and greater, with exceptions that allow the removal of trees 21 inches diameter and greater under specific circumstances to achieve other desired conditions. These exceptions are:

- Tree(s) need to be removed to favor hardwood species, such as aspen or cottonwood, or other special plant habitats
- Late seral species, such as grand fir, are competing with large diameter early seral species, such as ponderosa pine
- Tree(s) need to be removed to reduce danger/hazard trees along roads and in developed sites
- A limited amount of old forest trees need to be removed where strategically critical to reinforce and improve effectiveness of fuel reduction in wildland-urban interfaces

Design Elements Specific to Alternative C

Under Alternative C, all stands currently classified as old forest, which are located outside of wilderness and backcountry areas, would be designated as an old forest land management

allocation (MA 4C Old Forest). Table 99 displays the acres of old forest that would be allocated to MA 4C Old Forest Management Areas under Alternative C. These acres would be allocated in areas that would otherwise be allocated to MA 4A General Forest. Under Alternative C, old forest stands within MA 4C would be considered unsuitable for timber production and also unsuitable for timber harvest. No commercial harvest would occur within these old forest management areas, but prescribed fire and treatment of smaller diameter trees as fuel reduction treatments would be allowed. Treatments within MA 4C would consist mostly of thinning trees less than 8 inches diameter. Alternative C would contain a standard that would prohibit new road and trail construction within old forest. Alternative C would include a standard that would prohibit harvesting live trees 21 inches diameter and greater wherever the individual trees occur, with no exceptions.

Table 99. MA 4C old forest acres for Alternative C for each national forest

National Forest	MA 4C Acres
Malheur	205,391
Umatilla	95,177
Wallowa-Whitman	106,263

Design Elements Specific to Alternative D

Alternative D would not include a specific land management area allocation for old forest. Old forest stands within MA 4A would be included as lands designated as suitable for timber production and volume harvested from those stands would be chargeable volume contributing toward the allowable sale quantity. Alternative D would contain a guideline that would prohibit new road and trail construction within old forest. Alternative D would not include any standards or guidelines related to the management of individual live large diameter or old trees.

Design Elements Specific to Alternatives E and F

Alternative E would not include a specific land management area allocation for old forest stands. Old forest stands would not be included as lands considered suitable for timber production and timber volume harvested from them would not be chargeable volume contributing toward the allowable sale quantity. This alternative would contain a guideline that would prohibit new road and trail construction in old forest.

Alternative E would contain a guideline that requires management activities to retain live trees with certain old tree characteristics wherever the individual trees occur. The guideline would allow the specifics of these old tree characteristics to be developed on a project specific basis.

Design Elements Specific to Alternatives E-Modified and E-Modified Departure

Alternatives E-Modified and E-Modified Departure would not include a specific land management area allocation for old forest stands. Old forest stands would not be included as lands considered suitable for timber production and timber volume harvested from them would not be chargeable volume contributing toward the allowable sale quantity. These alternatives would not contain a guideline that would prohibit new road and trail construction within old forest stands.

Alternative E-Modified and E-Modified Departure would contain a guideline that requires retention and recruitment of old trees, large trees and legacy trees, wherever the individual trees occur, with exceptions. These exceptions are:

- Trees need to be removed to meet or maintain desired conditions for species composition on the landscape by removing shade tolerant species in favor of shade-intolerant species.
- Trees need to be removed from high density forest to meet or maintain desired conditions for low density stand conditions on the landscape where removal of smaller trees alone cannot achieve desired conditions.
- Trees need to be removed to control or limit the spread of insect or disease infestation.
- Trees need to be removed to reduce danger/hazard trees along roads or in developed sites where life or property damage is a concern.
- Trees need to be removed where strategically critical to reinforce, facilitate, or improve effectiveness of fuel reduction in wildland-urban interfaces.

These additional exceptions would apply only to large trees that do not also meet the definition of old trees:

- Trees need to be removed to favor aspen, cottonwood, whitebark pine or other special plant habitats.
- Trees needed to be removed to form key pieces in complex instream large wood structures.

For Alternative E-Modified, “old” trees would be defined as live trees with distinct features indicating ages of generally 150 years or more (see guidelines outlined in Van Pelt 2008). “Large" trees would be defined as live grand fir over 30-inches diameter at breast height or live trees of any other species over 21 inches diameter at breast height. “Legacy” trees would be defined as old trees that have been spared during past harvest or have survived stand-replacing natural disturbances and are thus significantly older than the average trees in the general area. This distinguishes them from other “residual” trees, which may also have been spared from harvest but are not always significantly older than the average trees in the area (Mazurek and Zielinski 2004; Franklin 1990).

Design Elements Specific to Alternative F

Alternative F would not include a specific land management area allocation for old forest stands. Old forest stands would not be included as lands considered suitable for timber production and timber volume harvested from them would not be chargeable volume contributing toward the allowable sale quantity. This alternative would contain a guideline that would prohibit new road and trail construction within old forest stands.

Alternative F would contain a guideline requiring management activities to retain all live old trees greater than 150 years old, except within lodgepole pine cover types, where the age-limit would be greater than 120 years old.

General Effects Related to Different Management Approaches

Some common approaches to managing old forest include specific restrictions on the treatment of individual large trees, usually via some form of diameter limits on harvesting; limiting harvesting or impacts to individual old trees; and/or designating specific old forest management areas. All of the alternatives except Alternative D incorporate some variation of one or more of these tactics

into their proposed old forest management. Another method of potentially conserving old forest is to establish general desired ranges of conditions or quantities, and allow comparisons of contemporary conditions to these desired conditions to inform whether specific management activities would be appropriate. In addition to individualized approaches in the form of restrictions or constraints on management activities, all of the different plan revision alternatives would also be implementing activities in a way that is consistent with the desired conditions for old forest structural stages.

Alternative A would continue using current old forest management direction, including the management direction from the Eastside Screens amendment. Among other requirements, this would largely result in the effective continuation of a 21-inch harvesting diameter cap applied to the harvesting of live trees. Similarly, Alternative B would include this same diameter cap as a guideline along with explicit situational exceptions. Alternative C would impose via a standard, a strict 21-inch diameter limit to harvesting, with no exceptions. The basic intent of these different approaches to diameter based restrictions on harvesting individual trees is to ensure the retention and recruitment of large, old trees which are critical components of old forest structure. However, there are some potential limitations associated with these practices.

One issue involves the weak correlation between tree diameter and tree age. Diameter can be a misleading way to estimate which trees are considered old. Silviculturists and foresters have known for a long time that diameter is an extremely poor criterion of tree or stand age (Smith et al. 1997). Individual growing conditions or species characteristics often influence diameter as much or more than age. On favorable sites, some fast-growing, short-lived tree species have the ability to grow relatively quickly to large diameters. Conversely, other trees may persist for many decades under adverse growing conditions, and thus they grow into a biologically old condition without ever increasing to an exceptionally large size.

Age data was collected on a subsample of individual live trees across the three Blue Mountains national forests as part of the continuous vegetation survey. Age of individual trees was determined by increment coring. Examination of these data shows that when looking at the major conifer species combined (true firs, Douglas-fir, pines, spruce, and larch), only 37 percent of the trees over 21-inches diameter were over 150 years old. Conversely, over 40 percent of these large trees were under 120 years old, and about 20 percent were under 100 years of age. When looking specifically at the grand fir, the disparity between large size and old age is even more pronounced. Only 20 percent of the large grand fir (over 21-inches diameter) were actually over 150 years old. Of this same group, 28 percent of trees were found to be less than 100 years old. Even among the largest subset of grand fir trees sampled (trees over 29-inches diameter), only 21 percent were found to be over 150 years old.

Consequently, the strict application of diameter limits may result in unintended negative ecological consequences by failing to restrict the removal of valued, but smaller old trees, while simultaneously prohibiting the removal of large diameter younger trees that are less desirable in terms of restoration goals. There have been substantial increases in the distribution of shade-tolerant species, particularly grand fir (Hessberg 1999; Stine et al. 2014; Hessburg et al. 2015) on sites historically dominated by shade intolerant species like ponderosa pine or western larch (see “Forest Vegetation” section). Many of the stands now contain large (over 21-inches diameter) younger trees with species compositions and stand structures that are not considered to be resilient to drought stress, insect or disease infestation, changing climate, and other ecosystem stressors. In these situations, harvesting some medium- and large-size trees may produce ecologically enhanced stand structure and species compositions (Stine et al. 2014).

By prohibiting the removal of these large younger trees that are often of an undesirable species, management activities constrained by the 21-inch diameter cap may not have sufficient flexibility to effectively manage stand density, structure, and/or species compositions toward the desired range of conditions. In addition to allowing the removal of small old trees that may provide important elements to the stands' function, the diameter limits may also result in the failure to remove large young trees that are creating a fuel hazard and are competing with the desired old trees. Leaving an excess of these young large trees can increase the potential for future drought or wildfires to kill the very trees that the policy was meant to protect (Spies et al. 2006; Franklin & Johnson 2012). Efforts to achieve density management goals may also be hampered by diameter limit restrictions which lead to the excessive removal of mid-sized trees and ultimately contribute to an over-simplification of stand structures (North et al. 2007; Triepke et al. 2011).

Various forms of diameter caps have also been used in regions outside of the northwestern U.S., and their effects on forest restoration goals have been examined. Triepke et al. (2011) modelled the long-term effects of implementing dry forest restoration treatments under a 16-inch diameter limit. Their results suggest that a blanket policy imposing diameter-limit harvesting would seriously impair the ability of managers to achieve or maintain restoration objectives. In particular, they found that applying the policy to dry mixed conifer forests would tend to promote closed-canopy conditions that favor the retention and regeneration of uncharacteristic proportions of shade tolerant, non-fire resistant conifer species. Fulé et al. (2006) examined an extreme example of a “minimal impact” diameter limited restoration treatment in dry southwestern mixed conifer. They found the restrictions also led to minimal effectiveness in terms of reducing stand densities and reducing crown fire potential. North et al. (2007) looked at restoration treatments implemented under a 30-inch diameter cap that has been widely applied in the Sierran mixed-conifer forests. Their results showed that the achievement of restoration objectives was hindered, in particular by the application of the strict diameter limit to all species. They supported a particular need for additional flexibility to allow for the removal of additional large shade tolerant species, which would in turn allow for the retention of additional desirable fire adapted species of intermediate size.

While timber harvesting on the National Forests is not revenue driven, but is done primarily to meet land management objectives, the continued economic viability of the Forest Service's private sector partners is part of what enables this work to be performed. Diameter caps can have negative financial impacts on the economic viability of timber harvesting (Zhou et al. 2008). The pace and scale of needed restoration work is commonly constrained by the amount of funding that is available for noncommercial treatments. Treatments that can be implemented via commercially viable harvests, or with treatments that are capable of producing some amount of merchantable material, can offset the costs of needed conservation work (Spies et al. 2006). As long as it supports other land management objectives, harvesting a higher proportion of larger trees, even harvesting only one or two larger trees per acre can significantly improve the financial viability of a harvest-based restoration treatment (Lynch 2001; Franklin et al. 2013).

To avoid the drawbacks associated with diameter limits, Alternative F takes a different approach to managing old forests and individual old trees by using a guideline requiring the retention of live trees greater than 150 years old, or greater than 120 years old within lodgepole pine cover types. Alternatives E, E-Modified, and E-Modified Departure also incorporate aspects of this “age-limit” approach in their parallel guidelines, but they emphasize identifying old trees by their distinguishing characteristics rather than explicit age measurements. Conservation of old trees and old forest based on age limits would eliminate the problems associated with using diameter as an age surrogate. This focus on older, rather than larger trees has been advocated by many in

recent years as a key part of a successful forest restoration strategy (Franklin & Johnson 2012; Franklin et al. 2013; Hessburg et al. 2015; Hessburg et al. 2016).

However, one concern with using age limits is that they would also tend to impose a somewhat arbitrary “one-age-fits-all” management strategy that may not fully address the complexity and variety of different forest conditions and component tree species. Old age for many tree species is often considered to be greater than 150 years old. However, old tree characteristics and meaningful old age thresholds vary greatly by species, forest type, disturbance regime and site conditions. Because the typical life span, growth rates and biological size limits of individual tree species vary greatly, the age at which old forest and old tree characteristics develop within the Blue Mountains region will also vary greatly. For example, common Blue Mountains long-lived trees like ponderosa pine, Douglas-fir, and western larch typically have a natural lifespan of 300 to 600 years (Burns and Honkala 1990). Exceptional individual specimens of these trees have even been documented with ages in excess of 900, 800 and 1,200 years respectively (RMTRR 2017). In this context, an “oldness” threshold of 150 years does not imply a high degree of biological significance for these species. It may, however, be a good fit for a species like grand fir, which rarely naturally exceeds 250 to 300 years of age. On the other hand, an age limit of 150 years may in fact be inappropriate for short-lived species like lodgepole pine, quaking aspen, or black cottonwood, none of which typically live more than 150 to 200 years (Burns and Honkala 1990). Across the board age-limits would likely be somewhat ineffective in the context of the natural complexity of the forests they are applied to.

The mechanics of establishing actual tree ages is also a factor that complicates the application of age-limits as a management tool. Nearly all reliable estimates of live tree age, especially for particularly old trees, are derived from tree rings. The principle used here is that in most trees that form rings, the rings are formed annually, so the number of rings in the tree will provide a fairly close approximation of the tree's age (Douglass 1940). A tool called an increment borer is commonly used as a hollow drill that takes out a core extending to the center of the tree. Age can be determined by counting the rings visible on the core sample. In practice, however, this would be onerous and impractical to perform at a large scale as part of a National Forest management or landscape restoration program. For example, to comply with the management direction written in Alternative F’s “OF-1” guideline, managers would effectively be required to prove that every individual tree that is potentially affected by a proposed management project, is in fact less than the explicit age limit listed in the guideline.

There are also numerous technical limitations with the increment boring technique itself that can lead to poor results, which adds to the complexity of complying with explicit age limits; (1) the centers of trees may be damaged or missing due to decay, making age determination impossible; (2) if the core is taken much above ground level, an estimation must be included to account for the time required to grow up to the sample height; (3) trees occasionally produce more than one ring a year; (4) trees occasionally go a year or more without producing a ring; and, (5) the rings themselves are not always readily distinguishable by human eyes in the field.

Alternatives E and E-Modified attempt to avoid some of the problems associated with explicit age-limits, by allowing for the relative age, or “oldness,” of the trees to be approximated by their physical appearance. For most tree species, certain tree characteristics can be used to infer old age (Van Pelt 2008). As Franklin and Johnson (2012) point out, older trees are not just large versions of their younger selves. Like many animal species, trees tend to acquire distinctive physiological and structural features in response to the aging process as well as the gradual accumulation of physical, insect and/or disease damage. Although it contains no guidelines specific to grand fir,

the use of guidelines like the ones proposed by Van Pelt (2008), as well as the development of new guidelines, would likely allow for the reasonably accurate identification of individual trees of significant age to occur in an efficient, practical manner.

Another general strategy for managing old forests that is included in the range of alternatives involves establishing specific areas within the forest that contain existing old forest stands, and are primarily focused on maintaining current old forest characteristics. Alternative A would continue with the current variations of old forest management areas discussed above in the Affected Environment section. However, only a minority of the old forest management areas established under Alternative A (see Table 97 on page 194) actually contain old forest structural stages. Many areas allocated to old forest management areas in the 1990 forest plans did not meet the definition initially and were chosen to meet patch size and distribution requirements, or were in effect, old forest "recruitment areas" that were expected to grow into old forest over time. But, though largely excluded from harvesting over the past 25-plus years, these old forest areas have been affected by many natural disturbances, such as fire, windthrow, insects and diseases. In some instances, acres dedicated to old forest management areas have since experienced major species composition and/or forest structure changes due to disturbances. These acres under Alternative A would remain allocated to old forest management areas, however, this approach seems unlikely to effectively meet the desired conditions which are seeking for a much greater representation of old forest stages on the landscape over the upcoming planning horizon.

Under Alternative C, a similar, but broader approach would be taken, as old forest stands outside of wilderness and backcountry areas would also be designated and placed into an old forest land management allocation (MA 4C Old Forest). Timber harvesting would be considered unsuitable within these areas and other silvicultural treatments would be significantly restricted. However, over time, some acres in MA 4C would likely be affected by natural disturbances and no longer remain within the old forest structural stage, while other areas outside of MA 4C would likely develop into old forest stages, yet not be managed in the same way as MA 4C.

The fundamental issue with the reserve area approaches of Alternatives A and C is that the natural variation in size, intensity, and frequency of disturbance regimes tends to contribute to a pattern of old forest, as well as other structure classes, that is not inherently stable on the landscape (Hessburg et al. 2005). The position of individual stands of old forest on the landscape was not static historically. Rather, old forest areas shifted spatially over time. As some old forest stands naturally succumbed to high severity disturbances, other areas naturally progressed from mid-aged and mature forest into old forest.

Modern principles of landscape ecology recognize this "shifting mosaic" concept. Historical forest structures and patterns are fluid across the landscape due to natural disturbances (Turner et al. 2001; Rogers 1996). As management emphasis of public lands has moved towards restoration and desired conditions based on the historical range of variability, many managers now recognize the need to mimic natural disturbances (Mitchell et al. 2002, Sarr et al. 2004; Long 2009; Geldenhuys 2010). Reliance on designated old forest management areas has now been determined to be largely ineffective to meet the desired conditions for old forest, because the concept essentially ignores the role of historical disturbance regimes and the resulting shifting of old forest structures across the landscape that would be expected to occur over time (Stine et al. 2014). Many believe that when natural disturbance is taken into account, the anticipated degree of loss of old forest from within designated reserves due to these natural processes will render the strategy counterproductive over time. Consideration of the context of natural disturbances indicates that maintaining old growth solely on a limited land base is a risk-prone strategy

(Klenner et al. 2000; Spies et al. 2006). The approaches that would be applied in Alternatives A and C may create a false sense of security and forego opportunities for both preventative maintenance and active recruitment of old forests.

Key Indicator: *Acres of old forest within management area allocations allowing limited or no management activity*

Table 100 displays the acres of old forest within management areas where only limited management activity would occur. These areas include designated or recommended wilderness, dedicated old forest management areas, roadless areas and other special areas like research natural areas. These are all areas where timber harvesting activities are expected to be either very limited in scope, or are not expected to occur at all. Alternative C would designate the largest amount of old forest acres to restrictive management allocations with the creation of the MA 4C Old Forest Management Areas. Alternative C would result in the most acres of old forest constrained within areas with little or no timber harvesting allowed. Most of these areas would otherwise have been allocated to MA 4A, General Forest, under the other alternatives.

Table 100. Acres of existing old forest within wilderness areas, old forest management areas, and backcountry areas for each alternative for each national forest

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur	78,000	81,000	350,000	73,000	85,000	79,000	79,000	85,000
Umatilla	142,000	188,000	322,000	176,000	191,000	181,000	181,000	191,000
Wallowa-Whitman	144,000	152,000	290,000	143,000	153,000	123,000	123,000	153,000

As discussed above, as forest stands change over time, some acres in MA 4C would naturally transition out of the old forest stages, while other areas outside of MA 4C would likely develop into old forest. Under Alternative C, old forest stands would be considered unsuitable for timber production and also unsuitable for timber harvest. Virtually no commercial harvesting would occur within these old forest management areas, but prescribed fire and harvesting of smaller diameter trees would be allowed. Treatments within MA 4C would consist mostly of thinning trees less than 8 inches diameter. Alternative C would also contain the greatest number of acres of preliminary administratively recommended wilderness areas, which would result in additional acres of old forest being reserved from active management.

Alternatives B, D, E, E-Modified, E-Modified Departure, and F would not include a specific land management area allocation for old forest. These alternatives would actively manage more old forest areas, because they would be outside of the restricted areas indicated above. The management direction in these alternatives would contain more flexibility in terms of allowing active management of old forest areas as long as the effects were consistent with overall desired conditions and specific standards or guidelines.

Alternatives A and D would have slightly lower amounts of old forest located within wilderness areas and other backcountry areas, though the differences between all of the alternatives, excluding C, are not particularly great.

Key Indicator: *Acres of timber harvesting within old forest stands*

Table 101 displays the estimated annual acres of timber harvest expected to occur within old forest stands. All of the alternatives contain the same desired conditions that would tend to

emphasize retaining current amounts of old forest and increasing these amounts over time. Given that, the harvesting occurring within old forest across all alternatives was assumed to be designed to maintain and encourage old forest attributes. One of the differences between the alternatives would be the amount of old forest annually treated with timber harvest, which could influence the rate at which the desired conditions would be achieved.

Table 101. Acres of predicted timber harvest (per year) within old forest stages for each alternative, and for each national forest

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur	500	800	0	4,800	1,600	2,200	2,600	1,000
Umatilla	300	500	0	2,900	1,000	700	900	500
Wallowa-Whitman	200	300	0	2,900	700	900	1,000	500
Total	1,000	1,600	0	10,600	3,300	3,800	4,500	2,000

Alternative A's continuation of "Eastside Screens" management direction for old forest would likely result in a continuation of annual timber harvesting within old forest stands similar to rates which have occurred in the recent past. Mostly as a result of forest plan amendments designed to allow direct conversion of multi-storied old forest into single-storied stages, old forest harvesting has ranged from approximately 200 to 500 acres per year, per National Forest.

Alternatives B and F would represent modest increases in the annual amount of timber harvesting projected to occur within old forest stands. This is largely a reflection of the absence of the "Eastside Screens" old forest harvesting restrictions associated with Alternative A. This direction requires the National Forests to compare existing conditions to estimates of historical levels of old forest prior to implementing most timber sales. If the amount of old forest in the landscape is found to be below the historical range of variation, the standard prohibits most timber harvesting within old forest stands. Alternatives B and F include relatively modest increases in overall harvesting and would consider timber harvesting within old forest stands to be a generally suitable use in many cases.

Alternative C stands out in this comparison with no timber harvesting expected to occur within old forest stands. Timber harvesting would not occur in old forest because all of the old forest stands would be allocated to areas which would consider both timber production management and timber harvesting to be unsuitable activities.

Conversely, Alternative D would result in the greatest amount of timber harvesting occurring within old forest stands. Under Alternative D, annual timber harvesting within old forest is projected to increase dramatically, to 10-times or more over current levels. Alternative D is unique among the alternatives in that it is the only one to include old forest stands within the land base considered suitable for timber production. Having these stands included in the regularly scheduled timber production management program is expected to result in a large increase in selection harvesting and commercial thinning, which could be implemented in ways that are compatible with the overall desired conditions for old forest structural stages.

Under Alternatives B, E, E-Modified, E-Modified Departure, and F, similar harvesting techniques and prescriptions as those used with Alternative D were expected to be used within old forest stands, but with all of these areas excluded from the suitable timber production land, entry into old forests was not assumed to occur nearly as often as it might under Alternative D. Both

Alternatives E and E-Modified were less constrained by budget assumptions than either B or F, so at full implementation levels, they show significantly more old forest harvesting occurring than either B or F.

Alternatives E-Modified and E-Modified Departure also incorporated a specific emphasis on treating the highly departed dry upland forest. Within the Malheur National Forest in particular, this translated into an expected increase over Alternative E in terms of conversion of old forest multi-storied stands into old forest single-storied stages.

The increase in expected old forest harvesting activities anticipated with Alternative E-Modified Departure is modest. With the old forest stands being excluded from the suitable timber production base, the E-Modified Departure alternative would not be expected to result in large changes in terms of old forest treatments. The slight increase in old forest harvesting shown for the Malheur National Forest under this alternative is likely the result of a slight increase in the opportunity to perform harvesting within newly developing old forest stands that is specifically designed to facilitate the maintenance of key old forest structural attributes and encourage the development of additional old forest characteristics.

Key Indicators: *Percent of old forest (all potential vegetation groups) at year 50 and the percent of the dry upland forest potential vegetation group in the old forest single-story structural stage at year 50*

Malheur National Forest

Refer to Table 102 for values supporting the following discussion for each potential vegetation group.

Cold Upland Forest Potential Vegetation Group – Within the Malheur's cold upland forest potential vegetation group, the existing conditions indicate a lack of old forest single story stands, while the cold old forest multi-story forest is within the natural range of variation. All of the alternatives would either achieve or come very close to maintaining the desired conditions for the single-storied and multistoried stages of old forest within the cold upland forest potential vegetation group. It is also noted, however, that all alternatives maintain the old forest single story stage at, or just shy of the very low end of the desirable range. Much of the cold upland forest potential vegetation group is located within existing or proposed wilderness, road-less or backcountry areas. Consequently, little active management was scheduled within the cold upland forest under any of the alternatives, so the similar results across alternatives may be driven largely by natural disturbance effects.

Table 102. Malheur National Forest old forest structural stages, as a percent of the potential vegetation groups*

Potential Vegetation Group and Structure	DC	EC	Alt. A Yr. 50	Alt. B Yr. 50	Alt. C Yr. 50	Alt. D Yr. 50	Alt. E Yr. 50	Alt. E-Mod. Yr. 50	Alt. E-Mod Dep. Yr. 50	Alt. F Yr. 50
Cold OFSS	5-20	1	6	6	7	5	5	6	6	5
Cold OFMS	10-25	20	17	17	16	12	13	19	19	14
Dry OFSS	40-65	3	13	11	10	16	16	19	20	12
Dry OFMS	1-15	20	20	20	22	16	15	15	15	19
Moist OFSS	10-20	5	7	5	6	6	6	4	4	6
Moist OFMS	15-20	47	34	35	35	30	31	30	30	33

Potential Vegetation Group and Structure	DC	EC	Alt. A Yr. 50	Alt. B Yr. 50	Alt. C Yr. 50	Alt. D Yr. 50	Alt. E Yr. 50	Alt. E-Mod. Yr. 50	Alt. E-Mod Dep. Yr. 50	Alt. F Yr. 50
All PVGs OFSS and OFMS (percent)	NA	25	33	31	31	30	30	34	34	30
All PVGs OFSS and OFMS (thousands of acres)	NA	365	484	461	462	452	439	493	503	451

OFSS = old forest-single story; OFMS = old forest- multi-story; DC = desired condition; EC = existing condition; PVG=potential vegetation group

* Key indicators are percent of old forest in all potential vegetation groups at year 50 and the percent of the dry upland forest potential vegetation group in the old forest single-story structural stage at year 50.

Dry Upland Forest Potential Vegetation Group – Within the Malheur’s dry upland forest potential vegetation group, the biggest concern in terms of old forest is the scarcity of old forest single story structure. While all of the alternatives would likely result in some level of increased old forest single story over the next 50 years, none of the alternatives would achieve the desired conditions for the old forest single story stage. This is largely due to the current magnitude of the gap between the existing and desired conditions, as well as the amount of time required to develop old forest structural attributes. Alternatives E-Modified and E-Modified Departure would result in the greatest expected increase in the old forest single story stage in the dry upland forest potential vegetation group at year 50, exceeding Alternatives D and E by approximately 3 to 4 percentage points. Alternatives B and C would result in the least amount of increase expected in terms of increasing dry upland old forest single story, with increases from the current 3 percent to levels of approximately 10 or 11 percent anticipated over 50 years.

Alternative C would allocate all existing old forest located outside of wilderness or backcountry areas to old forest reserve areas (MA 4C). Timber harvesting would be considered a generally unsuitable activity within these areas. Alternative C would also plan for the lowest acres of timber harvesting in general, and it would contain a standard that would strictly prohibit the harvesting of all live trees 21 inches diameter or greater. The indicators show that these management approaches would result in the least amount of progress towards moving the currently low levels of the dry upland forest old single-storied stage closer to the historical range of variability. Under the other plan revision alternatives, timber harvesting could be used within the dry upland forest’s existing old forest single-storied stands to control overall stand density, and limit the development of the understory tree layer. If left unchecked by either fire or thinning, these understory layers would otherwise tend to lead to the eventual succession of many single-storied stands into multi-storied stands. While prescribed fire can be used to some extent as a substitute treatment to maintain single-storied old forest stands of the dry uplands, without the availability of harvesting as an additional tool, under Alternative C more existing old forest single-storied stands would be expected to develop into multi-storied structures. Also, with less harvest thinning occurring within dense mature stands which are close to transitioning into old forest, more of these stands would be expected to experience severe disturbance and set back to the stand initiation stage rather than move on to the old forest stages.

Most of the differences between the alternatives in terms of moving toward the old forest single story goals for the dry upland forest seem to be correlated to the amount of active management and timber harvesting that is expected to occur. However, Alternative D, which has the greatest amount of harvesting occurring within old forest, falls short of the levels of improvement expected under either Alternative E-Modified or E-Modified Departure. Alternative E-Modified probably performs better in terms of restoring dry upland old forest single story structures,

because, while it does not schedule as much harvesting as Alternative D, it focuses its treatments more intently on addressing the pressing issues of the overstocked dry upland forest. It is also worth noting that while Alternative E-Modified Departure would greatly increase the rate of thinning within the dry forest, it is expected to achieve roughly the same end results as Alternative E-Modified in terms of dry old forest single story forest restoration.

The current conditions indicate that the Malheur's dry old forest multi-story stages are slightly above the upper limit of desired conditions. Alternatives D, E, E-Modified and E-Modified Departure would lower the dry old forest multi-story stage close to the upper limit of the desired range which is 15 percent. This would be the result of increased timber harvest activities associated with these alternatives. Timber harvest activities would be used for the direct conversion of the old forest multi-story stage to the old forest single story stage by decreasing stand densities and by removing smaller size classes in the understory. Harvesting would also be used for thinning mid-aged stands, which would tend to accelerate their future development into old forest single story instead of old forest multi-story. The other four alternatives would make little or no progress in reducing the existing surplus of dry old forest multi-story. Presumably the rates of direct conversion of old forest multi-story and thinning of mid-aged stands anticipated by Alternatives A, B, C and F would be too slow to offset the likely ingrowth of new understories and younger stands.

Moist Upland Forest Potential Vegetation Group – Within the Malheur National Forest moist upland forest potential vegetation group, the biggest issue is in terms of a large overrepresentation of the old forest multi-story stage. The old forest single story stage is slightly underrepresented. None of the alternatives would achieve the desired conditions for the percent of the moist upland landscape in the old forest single story or old forest multi-story stages at year 50. All of the alternatives would result in approximately 4 to 7 percent of the moist upland forest potential vegetation group attaining the old forest single story stage, which falls short of the desired minimum of 10 percent. All of the alternatives also show significant reductions of the moist old forest multi-story overtime. Alternatives D, E, E-Modified and E-Modified Departure would make the most progress in terms of moving the old forest multi-story stage closer to desired conditions. In 50 years, they would likely result in about 30 to 31 percent of the moist upland forest being old forest multi-story, compared to the upper end of the desired range which is 20 percent. Alternatives A, B and C would make the least progress, with around 34 to 35 percent of the moist upland forest remaining in the old forest multi-story stage. Since the old forest multi-story stage of the moist upland forest possesses characteristics that render it susceptible to mortality from fire, insects or disease (like multi-layered structures, many old trees, heavy fuel loads, and a preponderance of vulnerable species (Hemstrom 2001; Parker et al. 2006; Stine et al. 2014)), some of the overall reduction in moist old forest multi-story that occurs consistently across the alternatives is likely a result of modeled natural disturbances.

All Potential Vegetation Groups Combined – The overall amount of old forest stages on the Malheur is expected to increase across all alternatives within a 50-year timeframe. Alternatives E-Modified and E-Modified Departure would result in the greatest overall increase in old forest structure across all potential vegetation groups. These alternatives would likely result in an increase of old forest up to about 34 percent, from the current level of 25 percent. The general trends are similar across alternatives. Net reductions in old moist upland forests, likely due to natural disturbances, are offset by significant increases in old dry upland forests as well as modest increases in older cold upland forest stages.

Umatilla National Forest

Refer to Table 103 for values supporting the following discussion for each potential vegetation group.

Cold Upland Forest Potential Vegetation Group – Within the Umatilla's cold upland forest potential vegetation group, the existing conditions show a lack of old forest single story stands, while the cold old forest multi-story forest is somewhat above the upper limit of the natural range of variation. All of the alternatives would either achieve or come very close to maintaining the desired conditions for the single-storied and multistoried stages of old forest within the cold upland forest potential vegetation group. It is also noted, however, that all alternatives maintain the old forest single story stage near the very low end of the desirable range. Much of the cold upland forest potential vegetation group is located within existing or proposed wilderness, road-less or backcountry areas. Consequently, little active management was scheduled within the cold upland forest under any of the alternatives, so the similar results across alternatives may be driven largely by natural disturbance effects.

Table 103. Umatilla National Forest old forest structural stages, as a percent of the potential vegetation groups*

Potential Vegetation Group and Structure	DC	EC	Alt. A Yr. 50	Alt. B Yr. 50	Alt. C Yr. 50	Alt. D Yr. 50	Alt. E Yr. 50	Alt. E-Mod. Yr. 50	Alt. E-Mod Dep. Yr. 50	Alt. F Yr. 50
Cold OFSS	5-20	0	7	7	8	7	7	7	7	7
Cold OFMS	10-25	30	11	11	10	9	9	12	12	10
Dry OFSS	40-65	4	15	12	11	14	15	18	19	13
Dry OFMS	1-15	8	10	10	12	8	7	7	7	9
Moist OFSS	10-20	23	9	8	10	28	9	7	6	9
Moist OFMS	15-20	32	29	29	29	28	28	29	29	28
All PVGs OFSS and OFMS (percent)	NA	30	29	28	28	26	27	29	29	27
All PVGs OFSS and OFMS (thousands of acres)	NA	345	329	314	324	301	307	328	332	312

OFSS = old forest-single story; OFMS = old forest- multi-story; DC = desired condition; EC = existing condition; PVG=potential vegetation group

* Key indicators are percent of old forest in all potential vegetation groups at year 50 and the percent of the dry upland forest potential vegetation group in the old forest single-story structural stage at year 50.

Dry Upland Forest Potential Vegetation Group – Within the Umatilla dry upland forest potential vegetation group, the greatest concern regarding old forest is the scarcity of old forest single story structures. While all of the alternatives would likely result in some level of increased old forest single story over the next 50 years, none of the alternatives would achieve the desired conditions for the old forest single story stage. This is largely due to the current magnitude of the gap between the existing and desired conditions and the amount of time required to develop old forest structural attributes. However, Alternatives E-Modified and E-Modified Departure would result in the greatest expected increase in the old forest single story stage within the dry upland forest potential vegetation group by year 50, exceeding Alternatives D and E by approximately 3 to 4 percent. Alternatives B and C have the lowest expected results in terms of increasing dry upland old forest single story, with increases from the current 4 percent to levels of approximately 11 or 12 percent anticipated over 50 years.

Alternative C would allocate all existing old forest located outside of wilderness or backcountry areas to old forest reserve areas (MA 4C). Timber harvesting would be considered a generally unsuitable activity within these areas. Alternative C would also plan for the lowest levels of timber harvesting in general, and it would contain a standard that would strictly prohibit the harvesting of all live trees 21 inches diameter or greater. The indicators show that these management approaches would result in the least amount of progress towards moving the currently low levels of the dry upland forest old single-storied stage closer to the historical range of variability. Under the other plan revision alternatives, timber harvesting could be used within the dry upland forest's existing old forest single-storied stands to control overall stand density, and limit the development of the understory tree layer. If left unchecked by either fire or thinning, these understory layers would tend to lead to the eventual succession of many old single-storied stands into multi-storied stands. While prescribed fire can be used to some extent as a substitute treatment to maintain single-storied old forest stands of the dry uplands, without the availability of harvesting as an additional tool, under Alternative C more existing old forest single-storied stands would be expected to develop into multi-storied structures. Also, with less harvest thinning occurring within dense mature stands which are close to transitioning into old forest, a greater proportion of these transitional stands would be expected to experience severe disturbance and be set back to the stand initiation stage rather than move on to the old forest stages.

Most of the differences between the alternatives in terms of moving toward the old forest single story goals for the dry upland forest seem to be correlated to the amount of active management and timber harvesting that is expected to occur. However, Alternative D, which has the greatest amount of harvesting occurring within old forest, falls short of the levels of improvement expected under either Alternative E-Modified or E-Modified Departure. Alternative E-Modified probably performs better in terms of restoring dry upland old forest single story structures because, while it does not schedule as much harvesting as Alternative D, it focuses its treatments more intently on addressing the pressing issues of the overstocked dry upland forest. However, it is also worth noting that while Alternative E-Modified Departure would greatly increase the rate of thinning within the dry forest, it is expected to achieve roughly the same end results as E-Modified in terms of dry old forest single story forest restoration. Since time required to develop old forest structure is one of the biggest factors limiting the long-term rate of old forest restoration, increasing the rate of thinning may only go so far in terms of achieving overall restoration goals for old dry upland forest.

The current conditions indicate that the Umatilla's dry old forest multi-story stages are within the range of desired conditions. All of the alternatives would maintain the dry old forest multi-story stage near the midpoint of the desired range of 1 to 15 percent.

Moist Upland Forest Potential Vegetation Group – Within the Umatilla National Forest moist upland forest potential vegetation group, the biggest issue is a significant overrepresentation of the old forest multi-story stage. The old forest single story stage is also slightly overrepresented. None of the alternatives would achieve the desired conditions for the old forest multi-story stages by year 50. All of the alternatives show similar modest reductions of the moist old forest multi-story overtime, with reductions of 3 to 4 percentage points anticipated. Alternative C is the only alternative that achieves and maintains desired conditions for moist old forest single story, though by year 50 it is anticipated to drop to the lowest desirable level of 10 percent. All of the other alternatives except Alternative D show that moist old forest single story will likely drop slightly below the minimum level of 10 percent by year 50. Alternative D is unique among alternatives in that it would increase the overrepresented moist old forest single story stage up to 28 percent by year 50. This is likely a result of Alternative D's emphasis on commercial timber production.

With an elevated level of thinning occurring within dense mid-aged moist upland forest stands, more of these stands are staged to develop into old forest single story over the modeled 50 year period. Since the old forest multi-story stage of the moist upland forest possesses characteristics that render it susceptible to mortality from fire, insects or disease (like multi-layered structures, heavy fuel loads, many old trees, and a preponderance of vulnerable species (Hemstrom 2001; Parker et al. 2006; Stine et al. 2014)), some of the overall reduction in moist old forest multi-story that occurred across the other alternatives was probably the result of modeled natural disturbances.

All Potential Vegetation Groups Combined – The overall amount of old forest stages on the Umatilla is expected to decrease fairly consistently across all alternatives at a rate of 1 to 4 percentage points over 50 years. Though results are similar across alternatives, Alternatives A, E-Modified and E-Modified Departure would result in the smallest projected decreases in old forest structures across all potential vegetation groups. Generally, all alternatives show net increases in old dry upland forest that are offset by reductions in the overall levels of old moist and cold upland forests. These reductions may be linked to natural disturbances, since both the cold and moist upland forests are currently overrepresented by old forest multi-story stages, and these forest types tend to possess characteristics which are related to susceptibility to insect and disease disturbance as well as wildfire (Hemstrom 2001; Parker et al. 2006; Stine et al. 2014).

Wallowa-Whitman National Forest

Refer to Table 104 for values supporting the following discussion for potential vegetation groups.

Cold Upland Forest Potential Vegetation Group – Within the Wallowa-Whitman's cold upland forest potential vegetation group, the existing conditions indicate a lack of old forest single story stands and a corresponding overrepresentation of cold old forest multi-story forest. All of the alternatives would either achieve or come very close to maintaining the desired conditions for the single-storied and multistoried stages of old forest within the cold upland forest potential vegetation group. It is also noted, however, that all alternatives maintain the old forest single story stage near the very low end of the desirable range. Much of the cold upland forest potential vegetation group is located within existing or proposed wilderness, road-less or backcountry areas. Consequently, little active management was scheduled within the cold upland forest under any of the alternatives, so the similar results across alternatives may be driven largely by natural disturbance effects.

Dry Upland Forest Potential Vegetation Group – Within the Wallowa-Whitman dry upland forest potential vegetation group, the biggest concern is the scarcity of old forest single story structures. While all of the alternatives would likely result in some level of increased old forest single story over the next 50 years, none of the alternatives would achieve the desired conditions for the old forest single story stage. This is largely due to the current magnitude of the gap between the existing and desired conditions, as well as the amount of time required to develop old forest structural attributes. However, Alternatives E-Modified and E-Modified Departure would result in the greatest expected increase in the dry upland forest's old forest single story stage at year 50, exceeding Alternatives D and E by approximately 4 percentage points. Alternatives B and C have the weakest expected results in terms of increasing dry upland old forest single story, with increases from the current 1 percent to levels of approximately 7 or 8 percent anticipated over 50 years.

Table 104. Wallowa-Whitman National Forest old forest structural stages, as a percent of the potential vegetation groups*

Potential Vegetation Group and Structure	DC	EC	Alt. A Yr. 50	Alt. B Yr. 50	Alt. C Yr. 50	Alt. D Yr. 50	Alt. E Yr. 50	Alt. E-Mod. Yr. 50	Alt. E-Mod Dep. Yr. 50	Alt. F Yr. 50
Cold OFSS	5-20	1%	5	5	5	5	5	5	5	5
Cold OFMS	10-25	34%	20	20	20	20	20	21	21	20
Dry OFSS	40-65	1%	9	8	7	11	11	15	15	9
Dry OFMS	1-15	14%	11	11	12	8	8	7	7	9
Moist OFSS	10-20	1%	6	5	6	5	7	7	6	6
Moist OFMS	15-20	25%	17	17	17	15	16	15	15	17
All PVGs OFSS and OFMS (percent)	NA	32%	22	21	21	20	21	23	23	21
All PVGs OFSS and OFMS (thousands of acres)	NA	444	303	291	294	287	296	316	317	295

OFSS = old forest-single story; OFMS = old forest- multi-story; DC = desired condition; EC = existing condition; PVG=potential vegetation group

* Key indicators are percent of old forest in all potential vegetation groups at year 50 and the percent of the dry upland forest potential vegetation group in the old forest single-story structural stage at year 50.

Alternative C would allocate all existing old forest located outside of wilderness or backcountry areas to old forest reserve areas (MA 4C). Timber harvesting would be considered a generally unsuitable activity within these areas. Alternative C would also plan for the lowest levels of timber harvesting in general, and it would contain a standard that would strictly prohibit the harvesting of all live trees 21 inches diameter or greater. The indicators show that these management approaches would result in the least amount of progress towards moving the currently low levels of the dry upland forest old single-storied stage closer to the historical range of variability. Under the other plan revision alternatives, timber harvesting could be used within the dry upland forest’s existing old forest single-storied stands to control overall stand density, and limit the development of the understory tree layer. If left unchecked by either fire or thinning, these understory layers would tend to lead to the eventual succession of many old single-storied stands into multi-storied stands. While prescribed fire can be used to some extent as a substitute treatment to maintain single-storied old forest stands of the dry uplands, without the availability of harvesting as an additional tool, under Alternative C more existing old forest single-storied stands would be expected to develop into multi-storied structures. Also, with less harvest thinning occurring within dense mature stands which are close to transitioning into old forest, a greater proportion of these transitional stands would be expected to experience severe disturbance and be set back to the stand initiation stage rather than move on to the old forest stages.

Most of the differences between the alternatives in terms of moving toward the old forest single story goals for the dry upland forest seem to be correlated to the amount of active management and timber harvesting that is expected to occur. However, Alternative D, which has the greatest amount of harvesting occurring within old forest, falls short of the levels of improvement expected under either Alternative E-Modified or E-Modified Departure. Alternative E-Modified probably performs better in terms of restoring dry upland old forest single story structure because, while it does not schedule as much harvesting as Alternative D, it focuses its treatments more intently on addressing the pressing issues of the overstocked dry upland forest. It is also worth noting that while E-Modified Departure would greatly increase the rate of thinning within the dry forest, it is expected to achieve roughly the same end results as E-Modified in terms of dry old forest single story forest restoration. Since the time required to develop old forest structure is one

of the biggest factors limiting the long-term rate of old forest restoration, increasing the rate of thinning may only go so far in terms of achieving overall restoration goals for old dry upland forest.

The current conditions indicate that the Wallowa-Whitman's dry old forest multi-story stages are within the range of desired conditions. All of the alternatives would maintain the dry old forest multi-story stage near the midpoint of the desired range of 1 to 15 percent.

Moist Upland Forest Potential Vegetation Group – Within the Wallowa-Whitman National Forest moist upland forest potential vegetation group, the biggest issue is a significant lack of old forest single story and a modest overrepresentation of the old forest multi-story stage. None of the alternatives would achieve the desired conditions for the old forest single story stage at year 50. All of the alternatives would result in approximately 5 to 7 percent of the moist upland forest potential vegetation group moving into the old forest single story stage, which falls short of the desired minimum of 10 percent. All of the alternatives show significant reductions of the moist old forest multi-story overtime and they all are anticipated to be within the historical range of variability at year 50. Since the old forest multi-story stage of the moist upland forest possesses characteristics that render it susceptible to mortality from fire, insects or disease (like multi-layered structures, many old trees, heavy fuel loads, and a preponderance of vulnerable species (Hemstrom 2001; Parker et al. 2006; Stine et al. 2014)), some of the overall reduction in moist old forest multi-story that occurs consistently across the alternatives over time is likely a result of modeled natural disturbance effects.

All Potential Vegetation Groups Combined – The overall amount of old forest stages on the Wallowa-Whitman is expected to decrease fairly consistently across all alternatives from the current level of 32 percent to about 20 to 23 percent over 50 years. Although results are similar across alternatives, Alternatives E-Modified and E-Modified Departure would result in the smallest projected decreases in old forest structure across all potential vegetation groups. Generally, all alternatives show net increases in old dry upland forest that are offset by reductions in old moist and cold upland forests. These reductions may be linked to natural disturbances, since both the cold and moist upland forests are currently overrepresented by old forest multi-story stages, and these forest types tend to possess characteristics which are related to susceptibility to insect and disease disturbance as well as wildfire (Hemstrom 2001; Parker et al. 2006; Stine et al. 2014).

Key Indicator Summary

Table 105 through Table 107 display a summary of the key indicators for old forest by alternative. Although old forest is described using two structural stages (old forest single story and old forest multi-story) within three different potential vegetation groups, the focus is within the dry upland forest potential vegetation group, with the old forest single story stage as a key indicator. The dry upland forest potential vegetation group is the most dominant single vegetation group across the Blue Mountains, and the old forest single story stage would historically have represented 40 to 65 percent of the entire vegetation group. The old forest single story stage within the dry upland forest potential vegetation group exhibits the greatest amount of departure from the historical range of variation. In general, the current conditions for old forest within the cold and moist upland forest potential vegetation groups tend to be less departed from desired conditions than the dry upland forest potential vegetation group.

When all upland forest potential vegetation groups within a national forest are combined, and all old forest is analyzed at this broader scale, the predicted differences in the percent of the

landscape in old forest (old forest single story and old forest multi-story combined) would vary by approximately 1 to 4 percentage points between alternatives at year 50.

In terms of assigning old forest areas to limited activity management allocations, Alternative C took a unique approach. Alternative C would have all of the existing old forest located outside of wilderness and backcountry designated as an old forest management area, within which timber harvesting would be considered an unsuitable activity. As a result, Alternative C would have two to four times as much old forest constrained within areas of limited management as any of the other alternatives. However, when comparing the two results-oriented key indicators that track actual changes in old forest structure anticipated over time, Alternative C is not predicted to result in the existence of the most old forest structure at year 50. Although there is not a great deal of difference between the alternatives in terms of projected total old forest structures at year 50, Alternatives E-Modified and E-Modified Departure consistently achieve the highest predicted results against that indicator.

The indicator which specifically tracks changes in the old forest single story stage of the dry upland forest shows an even stronger negative correlation between the amount of old forest constrained within areas of limited management opportunity, and the continued development of old forest on the landscape. Alternative C is likely to produce the lowest performance in terms of increasing the future representation of dry old forest single story forest on the landscape. Alternatives E-Modified and E-Modified Departure, which entail relatively moderate levels of old forest reserve areas have the best expected performance on all three National Forests in terms of increasing the proportion of dry upland old forest single story stands over time.

These results lend credence to concerns that the strategy of maintaining old forest through designated reserves may be an ineffective approach. When natural disturbance like wildfire is taken into account, the anticipated degree of loss of old forest from within the designated reserves due to these natural processes is significant. These consequences suggest that this approach is prone to risk of failure. While Alternative C imposes the greatest level of area based restrictions on old forest management, the two indicators monitoring potential changes to old forest structure over time indicate that the strategy of area based restrictions or reserves is not the most effective approach toward old forest conservation, and may be counterproductive.

Table 105. Key indicators summary for old forest for each alternative for the Malheur National Forest

Key Indicator	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. E-Mod.	Alt. E-Mod. Dep.
Acres of old forest within management area allocations with limited management activity	78,000	81,000	350,000	73,000	85,000	85,000	79,000	79,000
Acres of vegetation treatments per year in old forest	500	800	0	4,800	1,600	1,000	2,200	2,600
Percent old forest at year 50 (all potential vegetation groups)	33%	31%	31%	30%	30%	30%	34%	34%
Percent dry upland forest in old forest single story stage at year 50	13%	11%	10%	16%	16%	12%	19%	20%

Table 106. Key indicators summary for old forest for each alternative for the Umatilla National Forest

Key Indicator	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. E-Mod.	Alt. E-Mod. Dep.
Acres of old forest within management area allocations with limited management activity	142,000	188,000	322,000	176,000	191,000	191,000	181,000	181,000
Acres of vegetation treatments per year in old forest	300	500	0	2,900	1,000	500	700	900
Percent old forest at year 50 (all potential vegetation groups)	29%	28%	28%	26%	27%	27%	29%	29%
Percent dry upland forest in old forest single story stage at year 50	15%	12%	11%	14%	15%	13%	18%	19%

Table 107. Key indicators summary for old forest for each alternative for the Wallowa-Whitman National Forest

Key Indicator	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. E-Mod.	Alt. E-Mod. Dep.
Acres of old forest within management area allocations with limited management activity	144,000	152,000	290,000	143,000	153,000	153,000	123,000	123,000
Acres of vegetation treatments per year in old forest	200	300	0	2,900	700	500	900	1,000
Percent old forest at year 50 (all potential vegetation groups)	22%	21%	21%	20%	21%	21%	23%	23%
Percent dry upland forest in old forest single story stage at year 50	9%	8%	7%	11%	11%	9%	15%	15%

An examination of the different levels of harvesting within old forest compared to the predicted changes in old forest structure over time also shows interesting results. Alternative C, which would restrict all timber harvesting from within old forest stands, is associated with the lowest expected performance in regards to promoting future dry old forest single story structure. Alternative D, however, which has the greatest amount of harvesting occurring within old forest, also falls short of the levels of dry old forest single story improvement expected under either Alternative E-Modified or E-Modified Departure. Alternative E-Modified probably performs better in terms of restoring dry upland old forest single story structures because, while it does not schedule as much harvesting as Alternative D, it focuses its treatments more intently on addressing the pressing issues of the overstocked dry upland forest. It is also worth noting that while Alternative E-Modified Departure would significantly increase the rate of thinning within the dry forest, it is only expected to achieve roughly the same end results as E-Modified in terms of dry old forest single story forest restoration. Since the required time of development is one of the biggest factors limiting the long-term rate of old forest restoration, increasing the rate of thinning may only go so far in terms of achieving the overall restoration goals for dry old forest. Since the base harvest schedule under Alternative E-Modified produces equally desirable results, it is questionable whether the increased cost and presumed increase in negative side effects associated with the departure alternative’s harvest schedule are warranted within the specific context of old forest restoration.

The general relationship between the harvesting levels and resulting old forest structure indicates that where the dry old forest single story structure stages are currently underrepresented, timber harvesting and other silvicultural activities could be expected to help move the landscape towards the desired conditions of the dry upland forest potential vegetation group in the old forest single story stage. However, under Alternative C, the potential to use timber harvesting as a tool to manage for old forest has been largely eliminated. Alternative C’s allocation of old forest to a land management area resulting in minimal amounts of active management would mean treatments within old forest would be confined to thinning trees less than 8 inches diameter. While these treatments may help to reduce stand densities and ladder fuels in some stands, it would be difficult to achieve the desired conditions for stand densities in the majority of old forest stands. Additionally, it would be difficult to achieve other desired conditions, such as species composition, with so few acres treated annually and with such limitations on thinning and harvesting treatments. The decreased levels and extent of timber harvest would allow for increased stand densities within old forest stands. Increased stand densities would result in increased crown contiguity, increased fuel loading and conditions more conducive to stand-replacing crown fire. Additionally, increased stand densities would result in increased competition between trees for moisture, nutrients, and sunlight, with a corresponding reduction in the old forests’ ability to resist diseases and insect attack. All of these conditions would tend to put old forest stands at higher risk of loss from natural disturbances.

Under Alternative C, vegetation treatments within old forest would rely heavily on the use of prescribed fire (planned ignitions) and wildfire (unplanned ignitions) managed for resource benefits to reduce stand densities, rather than harvesting trees. While the intent of prescribed fire under Alternative C would be to improve forest structure, stand density, and species composition within old forest, the results from fire are much less predictable than those of harvesting. Relying solely on the effects of fire in highly departed landscapes could result in substantially higher levels of mortality across all tree age and size classes, including the large and/or old tree component, depending upon burning conditions. Much of the dry upland forest potential vegetation group, including the old forest stands, currently exists in uncharacteristically closed

stand densities. In many cases, without the pretreatment effects of a timber harvest or other heavy thinning, it would be unrealistic to expect to immediately reintroduce fire and achieve desirable low or mixed severity effects.

Under the other Alternatives like D, E and E-Modified, although timber harvesting levels are high, activities implemented within old forest could remain consistent with the desired conditions for old forest structures by focusing on the direct conversion of old forest multi-story to old forest single story or by decreasing stand densities and favoring more fire tolerant tree species. As a result, these stands would more closely resemble the historical open canopy, single-story forest structure that existed prior to interruption of the historical fire regime. Similar harvesting treatments performed within dense mid-aged stands could foster the development of these stands toward future old forest single story status by reducing their current understories and increasing the development of large trees through density management. Despite its larger overall harvest schedule, Alternative D may fall short of some of the other alternatives in terms of old forest management goals, because it would be affected more by the competing objectives that go along with including the old forest in the suitable timber production base. Under Alternative D, regulated timber production would be an objective within many existing old forest stands, so the harvest treatments occurring within those stands may not always be designed to maintain old forest structures.

Another disadvantage of Alternative D in terms of old forest goals is related to the lower relative importance of prescribed fire (planned ignitions) associated with this alternative. Alternative D would not include prescribed burning outside of harvest units and would include very limited amounts of prescribed burning within harvest units. The majority of fuels treatments within harvest units would be accomplished by removal or crushing instead of burning. In limiting the use of prescribed fire, the alternative would limit the use of an effective and relatively low-cost tool that could be used to maintain the open low density conditions associated with the dry upland old forest single story stages.

Cumulative Effects

Potential cumulative effects were analyzed by considering the effects of the alternatives in the context of past, ongoing, and reasonably foreseeable future activities that have occurred within the vegetation cumulative effects analysis area. This analysis area consists of the 25 subbasins that contain the Malheur, Umatilla, and Wallowa-Whitman National Forests and other lands. The time period into the future considered was 50 years.

The three National Forests of the Blue Mountains region are revising their forest plans simultaneously. The three individual final revised Forest Plans will all contain the same desired conditions and will emphasize forest vegetation treatments that change the composition, density and structure in a similar fashion. With these three National Forests adjoining one another, the management direction established with these final revised Forest Plans should promote coordinated efforts that will complement each other in contributing to overall movement toward the historical range of variability and desired conditions for the restoration of appropriate levels of old forest across the landscape.

The vast majority of the forestland within the Plan Area is federally managed by one of the three National Forests. Most of the other forestland within and adjacent to the National Forests is either owned by private individuals or forest products companies, with a small amount being managed by Tribal governments or Federal agencies like the Bureau of Land Management. Timber harvesting and many other related silvicultural treatments on non-Federal forestlands are

controlled by State forest practices statutes, as well as a number of State and Federal regulations and incentives designed to protect the productivity and environmental quality of natural resources. The Forest Service does not have the authority to regulate any activities or their timing on lands other than those they administer.

Management objectives on these forestlands of other ownership often focus on fuel reduction and timber production. These ownerships also tend to be concentrated within the dry upland forest areas. The historical harvesting practices that took place on these lands were similar to those that occurred on the National Forests. As a result, much of the old forest structure of these areas has been previously harvested, and these lands contribute little of this structural stage to the overall landscape. Given that many of these other landowners are managing with timber production and fuel management in mind, old forests on other lands may become increasingly rare, making those on National Forest System lands even more valuable for both a social and ecological standpoint.

Land uses, subdivision, and development of privately owned forestland within the wildland-urban interface is expected to continue to occur at relatively modest rates and is not expected to significantly affect current conditions within the National Forests during the planning horizon.

Over much of last planning period, forest restoration efforts in the Blue Mountains have focused on addressing a long legacy of fire exclusion and historical timber harvesting practices that have created densely-stocked stands, mostly at lower elevations. The management direction of the 1990 plans, as amended, has significantly limited the amount of active management occurring within old forest stands. Active management has largely centered on improving the vigor of mid-aged low-elevation dry forests and reducing fire hazard in these same areas, primarily with mechanical treatments and prescribed fire. However, since the enactment of the Eastside Screens direction in 1995, numerous site specific forest plan amendments have been developed to permit individual projects to harvest limited numbers of trees over 21 inches diameter. The amendments have also been used to allow limited timber harvesting within old forest stands. Virtually all of these individual projects were designed to maintain existing old forest structure and promote the development of future old forest structure.

Under all of the plan revision alternatives, the desired future conditions call for significant portions of each upland forest potential vegetation group to exist within the old forest structural stages. Because many of these old forest structural stages are currently underrepresented, this objective for more old forest structure on the landscape will continue to conflict with some timber production objectives and related management systems. For example, all of the alternatives except Alternative D leave all current old forest stands out of the base of land designated as suitable for timber production. Consequently, the calculated allowable sale quantity limits under these alternatives tend to be lower. Old forest stands typically contain high per-acre volumes of timber as well as the largest, most economically desirable trees. But with the desired conditions for old forest unfulfilled, harvest entries within old forest stands would occur only on a limited basis, and many of the largest most valuable trees would have to be reserved to maintain old forest structures. The competing objectives of the old forest desired conditions would tend to preclude the use of many timber management systems like even-aged regeneration harvesting, or strictly regulated uneven-aged management systems.

Issue 5: Preliminary Administratively Recommended Additions to the National Wilderness Preservation System and Designated Wilderness

Introduction

Wilderness is a part of the national forest multiple use mandate. Historically, wilderness was instrumental in constructing America's unique heritage and shaping its national identity. The Wilderness Act of 1964 (P.L. 88-577) emphasizes protecting an "enduring" wilderness resource "for the American people of present and future generations." In an increasingly developed world accompanied by increased mechanization, the National Wilderness Preservation System (NWPS) was created to contrast these modifications and was established to ensure protection and preservation for wilderness areas in their natural conditions.

Section 2(c) of The Wilderness Act, "Definitions of Wilderness," states:

> A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

This definition highlights two subtle, but distinct concepts of wilderness (Scott 2001). The first provides an ideal concept of wilderness: areas that are untrammeled, undeveloped, and exemplify primeval character and influence without permanent improvements or human habitation. The second provides a practical definition as used for the purposes of the act and is "descriptive of the areas to which this definition applies" (Zahniser 1963). The two part definition, a conceptual ideal and a practical characterization, informs on both the act's intent and its application. Section(4)(b) of the act asserts that "Except as otherwise provided in this Act, each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area…" Wilderness stewardship and management has developed over the subsequent decades with an emphasis on how project or planning efforts modify wilderness character of a wilderness area. Forest Service and wilderness scholars, in describing wilderness character, selected five assessment "qualities." Landres et al. (2011) notes:

> Based on Section 2c, "Definition of Wilderness," in the 1964 Wilderness Act and building on the writing of Howard Zahniser (Zahniser 1956; Harvey 2007), wilderness scholars (Rohlf and Honnold 1988; McCloskey 1999; Scott 2002), and earlier work to describe and use wilderness character (Landres et al. 2005; Landres et al. 2008b), an interagency team published Keeping It Wild (Landres et al. 2008a), which identified four distinct and necessary "qualities" of wilderness character. These qualities were selected to be tangible, link local conditions and management directly to the statutory language of the 1964 Wilderness Act, and apply throughout the entire area of a wilderness. They apply to every wilderness regardless of size, location, agency administration, or any other attribute.

The four distinct qualities described below are used to assess wilderness character and represent a combination of attributes that define and describe the character of wilderness (Landres et al. 2011):

> **Natural:** Wilderness ecological systems are substantially free from the effects of modern civilization. This quality is degraded by many things, such as loss of indigenous species, occurrence of nonindigenous species, alteration of ecological processes such as water flow and fire regimes, effects of climate change, loss of dark skies, and occurrence of artificial sounds. It is preserved or improved, for example, by controlling or removing nonindigenous species or restoring ecological processes.
>
> **Undeveloped:** Wilderness retains its primeval character and influence and is essentially without permanent improvement or modern human occupation. This quality is influenced by what are commonly called the "Section 4c prohibited uses," that is, the presence of modern structures, installations, habitations, and use of motor vehicles, motorized equipment, or mechanical transport. The removal of structures and not conducting these prohibited uses preserve or improve this quality. In contrast, the presence of structures and prohibited uses degrades this quality, whether by the agency for administrative purposes, by others authorized by the agency, or when there are unauthorized uses.
>
> **Untrammeled:** Wilderness is essentially unhindered and free from the actions of modern human control or manipulation. This quality is influenced by any activity or action that controls or manipulates the components or processes of ecological systems inside the wilderness. Management actions that are not taken support or preserve the untrammeled quality, while actions that are taken degrade this quality, even when these actions are taken to protect resources, such as spraying herbicides to eradicate or control nonindigenous species or reducing fuels accumulated from decades of fire exclusion.
>
> **Solitude or a pristine and unconfined type of recreation:** Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation. This quality is primarily about the opportunity for people to experience wilderness, and is influenced by settings that affect this opportunity. It is preserved or improved by management actions that reduce visitor encounters and signs of modern civilization inside the wilderness. In contrast, this quality is degraded by agency-provided recreation facilities, management restrictions on visitor behavior, and actions that increase visitor encounters.

Landres et al. (2011) also states:

> In addition to these four qualities, there may be a fifth quality, called other features, based on the last clause of Section 2c in the 1964 Wilderness Act, that a wilderness 'may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.' Unlike the preceding four qualities that apply to every wilderness, this fifth quality is unique to an individual wilderness based on the features that are inside that wilderness. These features typically occur only in specific locations within a wilderness and include cultural resources, historical sites, paleontological sites, or any feature not in one of the other four qualities that has scientific, educational, scenic, or historical value.

Wilderness provides both social and biophysical benefits and values. Social benefits outlined in Section 2 (a) of the Wilderness Act state that wilderness "shall be administered for the use and enjoyment of the American people." Cole (2005) notes that wilderness experiences include recreational and social benefits described as spiritual, educational, transcendental, and symbolic. Ecological benefits include maintaining species diversity, conserving a "reservoir" of ecological

processes and a diversity of genetic material, protecting threatened and endangered species, protecting watersheds, maintaining large, contiguous, nonfragmented wildlife habitats, and serving as a base line for natural conditions to compare with changes in other environments (Dawson and Hendee 2009). While these attributes may have overlapping benefits, they represent themes and values commonly attached to wilderness.

Wilderness provides social, cultural, economic, scientific, and ecological benefits for present and future generations. Many of America’s iconic landscapes include wilderness areas that provide outstanding opportunities for solitude and/or a primitive and unconfined type of recreation. Wilderness landscapes may also contain culturally significant and sacred sites important to Native Americans, and historic-era cultural resources that speak to the nation’s collective heritage. Communities enjoy and value these lands for hunting and fishing, wildlife watching, hiking, equestrian pursuits, and other nonmotorized and nonmechanical uses. Wilderness areas are acknowledged as a scarce and dwindling resource, requiring humility on behalf of humanity in order to retain their natural condition and to convey an understanding of human and natural history. Wilderness serves as a baseline demonstrating the functions of healthy ecosystems that can be contrasted with human activities that change our world. Wilderness areas provide a variety of valuable ecosystem services including carbon sequestration, watershed protection, and air quality, and may contain habitat for numerous threatened and endangered species and other rare biological resources. Managing an area to protect its wilderness character provides unique opportunities and benefits for present and future generations that may otherwise be irreparably lost.

Changes Made Between the Draft and Final Environmental Impact Statements

Aside from the global changes throughout this environmental impact statement described in the Preface to this document, the following changes were made specifically to this section:

Review of Recommended Wilderness Areas: In response to numerous comments on the Draft Revised Forest Plan and supporting environmental impact statement that expressed concerns for recommended wilderness areas, each recommended wilderness area was reviewed. Reviews included reanalyzing each area for its consistency with agency regulations and criteria for recommending wilderness, and consistency with the Regional Forester’s direction to confirm that wilderness recommendation proposals meet agency criteria and have wilderness characteristics that would make them potentially eligible for inclusion in the National Wilderness Preservation System.

As a result of the forests’ reviews, the MA 1B (preliminary recommended wilderness area) acreage decreases by approximately 24 percent compared to Alternative E for the three National Forests combined. The reduction is based on additional reviews of existing summer and winter motorized uses, existing mining activity, boundary manageability, and areas that do not have sufficient wilderness characteristics to be suitable for wilderness designation. One MA 1B area slightly increases in acreage.

Revised Forest Plan Content: In response to internal forest service reviews and public comments, the guideline for MA 1B (recommended wilderness areas) and 1C (wilderness study areas) was changed to a Standard. The modification better aligns the revised forest plan with existing Forest Service regulation and policy (36 CFR 219.10 (b)(iv) and FSM 1923.03 (3)).

To provide for enhanced management direction for MA 1B, recommended wilderness areas, two additional guidelines were developed: MA1B-2G provides direction regarding mechanized (bicycle) use in recommended wilderness areas; and MA1B-3G provides guidance regarding motorized equipment use within recommended wilderness areas. These additions provide improved consistency with recommended wilderness area management direction contained in revised forest plan efforts within the broader region.

In response both public concerns and internal forest service review, the suitability ratings for uses and activities were evaluated for their constancy with existing forest service regulation and policy regarding MA 1B, recommended wilderness areas. Based on this review, the rating for “motor vehicle use (winter)” was changed from “suitable” for Alternative E to “unsuitable” for Alternative E-Modified and Alternative E-Modified Departure.

Key Indicators:

- Acres allocated to MA 1B Preliminary Administratively Recommended Wilderness Areas
- Acres of potential wilderness area allocated to other management area categories.

Methods

As part of the plan revision process, the Forest Service is required to evaluate inventoried roadless areas and assess their wilderness characteristics and to make recommendations regarding their inclusion in the National Wilderness Preservation System (36 CFR 219.7 (c)(2)(v)). Through the Wilderness Act of 1964 (PL 88-577), Congress created the National Wilderness Preservation System to provide protection for lands untrammeled by man. This act provides direction for the U.S. Department of Agriculture and the Secretary of the Interior to recommend suitable primitive areas for addition to the National Wilderness Preservation System. The Forest Service can only recommend wilderness area allocations to Congress via forest plans, and only Congress can designate wilderness areas through the legislative process. Recommendations and designation are often controversial and Congress may defer the issue for many years before taking action. In the interim, the Forest Service is required to manage preliminary administratively recommended wilderness areas to protect their wilderness characteristics and values for potential inclusion to the National Wilderness Preservation System.

During the 1980s, the national forests in the Blue Mountains evaluated 978,000 acres in 60 inventoried roadless areas for possible wilderness area recommendations to Congress. No acres were recommended for wilderness area designation in the 1990 forest plans, primarily as a result of the intervening passage of the Oregon Wilderness Act of 1984 (P.L. 98-328) that designated 931,000 acres of wilderness state-wide.. Consequently, the 1990 Blue Mountains national forest plans allocated approximately 272,700 acres to management areas that partially preserved their undeveloped character, and 428,800 acres were allocated to management areas that allowed for active management, including further development of the transportation system. For the current forest plan revision process, a total of 84 potential wilderness areas comprising approximately 719,030 acres were evaluated for wilderness characteristics and potential suitability for inclusion in the National Wilderness Preservation System. All of the acres evaluated are within the national forests and represent almost 13 percent of the total area.

In addition to the Blue Mountains Forest Plan Revision inventory process that considered National Forest System lands, the inventory also included an inventory of lands with wilderness characteristics that was completed by the Bureau of Land Management. The Bureau of Land Management classified three areas near the Forest Service boundary as lands with wilderness

characteristics. These areas, situated adjacent to potential wilderness areas, are managed as Bureau of Land Management lands with wilderness characteristics. The three areas comprise a relatively minor portion and contribution of the total potential wilderness area acres. The Bureau of Land Management is the lead agency for these parcels, but they are included in the reports for those potential wilderness areas.

A total of 84 areas on the Blue Mountains national forests were evaluated for potential suitability for inclusion in the National Wilderness Preservation System using standards outlined in Forest Service Handbook (FSH) 1909.12, Chapter 70 – Wilderness Evaluation (2007). An area recommended as suitable for wilderness area designation must meet the tests of capability, availability, and need. In addition to the inherent wilderness quality it possesses, an area must provide opportunities and experiences that are dependent upon or enhanced by a wilderness environment. The ability of the Forest Service to manage the recommended wilderness area must also be considered.

Capability is defined as the degree to which the area contains the basic characteristics that make it suitable for wilderness designation without regard to its availability for or need as wilderness. It is the degree to which an area contains wilderness qualities. These include the integrity of the natural environment and scenery; opportunities for solitude, challenge, and primitive recreation; and unique ecological or cultural features. Factors, such as size, shape, relationship to external influences, and boundary location, were examined to determine manageability (FSH 1909.12 Chapter 70 subpart 72.1; 2007).

Availability is conditioned by the value of and need for the wilderness area resource compared to the value of and need for other resources. A brief description of uses, wildlife, water resources, livestock grazing, timber, minerals, oil and gas, cultural resources, land use authorizations, lands not federally administered, and disturbances is included in the availability section of each potential wilderness area evaluation (FSH 1909.12 Chapter 70, subpart 72.2; 2007). These evaluations are available in the planning record.

Need for wilderness designation is determined through an analysis of the degree to which an area contributes to the National Wilderness Preservation System based on several factors on both a regional and a local basis. Need evaluations have been documented in the Forest Service Region 6 Wilderness Need Evaluation for the Malheur, Umatilla, and Wallowa-Whitman National Forests (January 11, 2010). The Blue Mountains national forests needs evaluation includes potential contributions to the local and national distribution of wilderness areas and associated ecological and social values (FSH 1909.12 Chapter 70, subpart 72.3; 2007).

The following six factors and criteria from the Forest Service Handbook (FSH 1902.12, Chapter 70 Subpart 72.31; 2007) were used to assess wilderness need:

1. The location, size, and type of other wilderness areas in the general vicinity and their distance from the proposed area. Considering accessibility of areas to population centers and user groups. Public demand for wilderness may increase with proximity to growing population centers.
2. Present visitor pressure on other wilderness areas, the trends in use, changing patterns of use, population expansion factors, and trends and changes in transportation.
3. The extent to which nonwilderness lands on the national forests or other Federal lands are likely to provide opportunities for unconfined outdoor recreation experiences.

4. The need to provide a refuge for those species that have demonstrated an inability to survive in less than primitive surroundings or the need for a protected area for other unique scientific values or phenomena.
5. Within social and biological limits, management may increase the capacity of established wildernesses to support human use without unacceptable depreciation of the wilderness resource.
6. An area's ability to provide for preservation of identifiable landform types and ecosystems. Consideration of this factor may include utilization of Edwin A. Hammond's subdivision of landform types and the Bailey-Kuchler ecosystem classification. This approach is helpful from the standpoint of rounding out the National Wilderness Preservation System and may be further subdivided to suit local, subregional, and regional needs.

Inventoried roadless areas are defined by a combination of rules and regulations. As part of the forest plan revision process, inventoried roadless areas provided a starting point for the review process to assess all areas for potential wilderness area designation. Areas were evaluated based on criteria outlined above.

In this analysis, the alternatives differ in the total areas recommended for preliminary administratively recommended additions to the National Wilderness Preservation System and areas recommended for nonwilderness.

Preliminary Administratively Recommended Wilderness Areas and Designated Wilderness – Affected Environment

As noted in the introduction to this section, designated wilderness is one of many multiple uses within the Forest Service as described by the National Forest Management Act of 1976 (Public Law 94-588). Units of the National Forest System shall assure that plans "provide for multiple use…and in particular, include the coordination of outdoor recreation, range, timber, watershed, wildlife and fish, and wilderness; . . ." Preliminary administratively recommended wilderness areas should include, as a foundation, an understanding of designated wilderness, and their interrelatedness. The following section provides relevant information about designated wilderness and the National Wilderness Preservation System and how it is related to administratively recommended wilderness.

The Wilderness Act of 1964 designated roughly 9.1 million acres of wilderness distributed in 54 areas located within 13 states. Since 1964, the National Wilderness Preservation System has grown significantly. The National Wilderness Preservation System has expanded through subsequent legislation totaling 104 wilderness bills, typically establishing wilderness areas through state-wide designations. Numerous bills are pending in Congress that would create millions of acres of new wilderness areas in national forests, national parks, national wildlife refuges, and land administered by the Bureau of Land Management. Two bills identified in the 113th Congressional session would designate wilderness areas in Oregon; however none of these bills propose wilderness designation for lands administered within the Blue Mountains national forests.

The National Wilderness Preservation System includes 765 wilderness areas encompassing approximately 109 million acres, or roughly 5 percent of the total United States land mass. The Forest Service manages approximately 36 million acres in 445 wilderness areas, representing approximately 19 percent of all National Forest System land. In Oregon, there are a total of 2.5 million acres of designated wilderness equaling about 4 percent of the State land area. Oregon

wildernesses represent about 2.3 percent of the area in the National Wilderness Preservation System.

The Blue Mountains national forests currently manage nearly 1 million acres of wilderness distributed across 7 designated wildernesses. The Hells Canyon Wilderness, consisting of 217,927 acres, is “nested” within the larger Hells Canyon National Recreation Area (HCNRA). The HCNRA Comprehensive Management Plan was updated and approved in 2003 and will be carried forward in its entirety. The HCNRA Comprehensive Management Plan is the portion of the Wallowa-Whitman National Forest Land and Resource Management Plan that guides management of the Hells Canyon National Recreation Area. Designated wilderness on the Blue Mountains national forests includes 759,666 acres in six wilderness areas, not including the Hells Canyon Wilderness. The following six wilderness areas are solely managed by the Blue Mountains national forests:

Eagle Cap Wilderness – This is Oregon's largest wilderness encompassing 350,461 acres in the heart of the Wallowa Mountains on the Wallowa-Whitman National Forest in Wallowa County, Oregon. Approximately 534 miles of trail give access to this area. This vast region has roughly 60 high alpine lakes, which are surrounded by open meadows, bare granite peaks and ridges, and classic U-shaped glacial valleys thickly forested in their lower sections and rising to scattered stands of alpine timber. Elevations range from roughly 5,000 feet to 9,845 feet on Matterhorn Peak located centrally within the wilderness area. Many fish species can be found in over 37 miles of streams.

Monument Rock Wilderness – This 19,650-acre wilderness is shared by the Malheur (12,620 acres) and Wallowa-Whitman (7,030 acres) National Forests in Baker and Grant Counties. The area ranges from 5,200 feet in the lower regions to the 7,815-foot peak of Table Rock. The season of highest visitation generally runs from June into November. The area receives 40 inches of annual precipitation and summer brings hot days and chilly nights. Hunting is the most popular activity, with hiking and backpacking increasing in popularity.

North Fork John Day Wilderness – This wilderness is located mostly in Grant County (Umatilla National Forest) with a small portion in Umatilla County (Wallowa-Whitman National Forest), Oregon. This 121,352-acre wilderness features rolling bench lands, the majestic Greenhorn Mountains, and the rugged gorge of the North Fork John Day River. Trails serving this area are popular for both hiking and horseback riding and are accessible from early spring to late fall from several trailheads located around its perimeter. The nature of the area provides long-distance trips with significant elevation changes. The wilderness includes four separate units. In addition to the main body of the wilderness, the Baldy Creek Unit lies to the east (on the Wallowa-Whitman National Forest), the Greenhorn Unit lies to the south (bordering the Vinegar Hill-Indian Rock Scenic Area), and the Tower Unit lies just to the north and includes Tower Mountain.

North Fork Umatilla Wilderness – At 20,435 acres, this is one of the smaller wilderness areas in northeast Oregon, and is located on the Umatilla National Forest in Union and Umatilla Counties. The area feels much bigger and visitors find the area peaceful, yet challenging as the wilderness is characterized by varying terrain; elevation ranges from 2,000 to 6,000 feet. Using the low elevation areas, hikers and equestrians on the 31-mile trail system have ample opportunity for spring hiking and horseback-riding trips. A main attraction is the North Fork Umatilla River.

Strawberry Mountain Wilderness – This 69,350-acre wilderness, located on the Malheur National Forest in Grant County, has over 100 miles of hiking trails crossing through the area dominated by the Strawberry Mountain Range. This area has extremely diverse ecological makeup; five of the seven major life zones in North America can be found here. The land is rugged; elevations range from 4,000 feet to the 9,038-foot summit of Strawberry Mountain.

Wenaha-Tucannon Wilderness – This 177,423-acre wilderness on the Umatilla National Forest is in Wallowa County, Oregon, and Columbia County, Washington. It contains 200 miles of managed trails providing a primitive, unconfined recreation experience. The landscape is rugged, with high basalt ridges separated by deep, steep canyons. Major streams include the Wenaha River, Tucannon River, and Crooked Creek. Elevations range from 2,000 feet at the Wenaha River to 6,400 feet at Oregon Butte.

Within the Malheur National Forest, about 5 percent or 82,000 acres are designated wilderness areas. Within the Umatilla National Forest, about 22 percent, or 304,200 acres are designated wilderness areas. Within the Wallowa-Whitman National Forest, about 24 percent, or 588,700 acres are designated wilderness areas.

The Wallowa-Whitman National Forest administers a portion of the Homestead Wilderness Study Area which is located within the Homestead Inventoried Roadless Areas. The wilderness study area, including the neighboring Federal lands managed by the Bureau of Land Management, contains about 14,000 acres of public land. The 1991 Bureau of Land Management wilderness study process included the national forest acres and did not propose to recommend this wilderness study area for wilderness designation. The study has not yet been accepted by Congress, so these acres remain in the wilderness study area category. Wilderness characteristics will be protected until such time as Congress either designates the area as part of the National Wilderness Preservation System or releases the area from consideration.

There are no preliminary administratively recommended wilderness areas in the 1990 forest plans for the Malheur, Umatilla, or Wallowa-Whitman National Forest.

Designated wilderness is governed by the terms of the Wilderness Act and other specific legislation, directing management activities within wilderness and reducing human impacts and influences to desired levels. These regulations are designed to protect the qualities of wilderness character. As mentioned in the affected environment section, effects to wilderness are measured by how any particular project or planning effort may impact the wilderness character of a wilderness area. Project proposals within these areas are evaluated for compliance with wilderness values and maintaining the respective five qualities of wilderness character. Commercial services in wilderness is controlled by special use permits and the operation plans that are required under the special use permits.

Because direction for wilderness management is detailed in law, regulation, agency policy, and in specific management plans, management of existing wilderness does not vary by alternative.

Preliminary Administrative Recommendations for Wilderness

Scoping was conducted on the Blue Mountains forest plan revision proposed action in the spring of 2010, and numerous issues and concerns were raised about the inventory of areas that may be suitable for inclusion in the National Wilderness Preservation System. Some respondents asked that additional areas that may be suitable for inclusion in the National Wilderness Preservation System be made to protect wilderness characteristics and the associated values they attach to wilderness areas. Others requested that no additional areas be recommended for inclusion in the

National Wilderness Preservation System because they believe management of these areas to protect wilderness characteristics would prevent them from participating in the activities that they currently enjoy within those areas. Proposals are preliminary administrative recommendations that will be further reviewed and possibly modified by the Chief of the Forest Service, Secretary of Agriculture, and the President of the United States. Congress has reserved the authority to make final decisions on wilderness area designation.

Wilderness area designation precludes the use of motorized and mechanical transport, including motor vehicles, and imposes limitations on management activities. Wilderness areas offer human visitors solitude and opportunities for challenge, risk, and primitive and unconfined recreation. Wilderness areas are managed to ensure that human influence does not impede natural processes or interfere with natural succession in the ecosystem. Areas chosen to be preliminary administratively recommended for addition to the National Wilderness Preservation System are allocated to MA 1B under the revised forest plans. As noted previously, only Congress has the authority to make wilderness designations. MA 1B areas would be managed to maintain the quality of wilderness characteristics that make them eligible for wilderness area designation, but they are not designated as a result of being allocated to MA 1B.

The need for additional wilderness designation in the Blue Mountains national forests was assessed in “Wilderness Need Evaluation for the Malheur, Umatilla, and Wallowa-Whitman National Forests” (USDA Forest Service 2010) and is included in the planning record. The report findings, based on the above criterion, reveal that additional wilderness designation is not necessary within the Blue Mountains national forests. Protection of areas with wilderness characteristics including the biological species and resources that they contain may be better achieved through alternative land management designations or other legal authorities. However, it is noted that wilderness recommendations may also be made based on needs brought forward through public comment. Therefore, the decision to propose a wilderness recommendation may be made based on various land management strategies and factors, all of which include maintaining biological and natural function and diversity within and on the natural landscape.

Preliminary Administratively Recommended Wilderness Areas – Environmental Consequences

General Effects

The following is a discussion of the general effects of recommending wilderness. Alternatives A and D do not propose any new areas for wilderness recommendation. Alternative B proposes the least number of recommended wilderness areas (four recommended wilderness areas totaling 13,400 acres); Alternative C proposes the greatest number of recommended wilderness areas (49 recommended wilderness areas totaling 505,000 acres); and Alternatives E and F are similar and propose an intermediate value (10 recommended wilderness areas totaling 90,800 acres). Alternative E-Modified and Alternative E-Modified Departure are the same (seven recommended wilderness areas totaling 70,500 acres; an intermediate value similar to, but slightly less than Alternatives E and F). Table 108 through Table 110 display the total number of acres proposed for wilderness recommendation by alternative, and Table 111 displays a summary of these totals.

Table 108. Acres of preliminary administratively recommended wilderness areas for each alternative for the Malheur National Forest

Preliminary Recommended Wilderness Areas	Alt. A	Alt. B	Alt. C	Alt. D	Alts. E and F	Alts. E-Mod. and E-Mod. Dep.
Aldrich Mountain	NA	NA	4,870	NA	NA	NA
Cedar Grove	NA	NA	5,650	NA	NA	NA
Dry Cabin	NA	NA	12,140	NA	NA	NA
Greenhorn	NA	NA	12,630	NA	6,139	NA
Jumpoff Joe	NA	NA	2,130	NA	NA	NA
McClellan Mountain	NA	NA	23,150	NA	23,145	23,580
Myrtle Silvies	NA	NA	10,930	NA	NA	NA
Shaketable	NA	NA	7,652	NA	NA	NA
Strawberry Mountain Wilderness Area Additions	NA	1,160	3,983	NA	1,160	2,990
Totals	**NA**	**1,160**	**83,810**	**NA**	**30,447**	26,570

Table 109. Acres of preliminary administratively recommended wilderness areas for each alternative for the Umatilla National Forest

Preliminary Recommended Wilderness Areas	Alt. A	Alt. B	Alt. C	Alt. D	Alts. E and F	Alts. E-Mod. and E-Mod. Dep.
Asotin Creek	NA	NA	16,180	NA	NA	NA
Greenhorn Mountain	NA	NA	11,275	NA	7,733	NA
Hellhole	NA	NA	67,071	NA	21,980	21,780
Horseshoe Ridge	NA	NA	6,270	NA	NA	NA
Jumpoff Joe	NA	NA	5,240	NA	NA	NA
Meadow Creek	NA	NA	1,780	NA	NA	NA
Mount Emily	NA	NA	5	NA	NA	NA
North Fork John Day Wilderness Area Additions	NA	1,170	3,830	NA	1,241	1,170
North Fork Umatilla Wilderness Area Additions	NA	270	970	NA	235	280
North Mount Emily	NA	NA	4,616	NA	NA	NA
Owsley	NA	NA	7,620	NA	NA	NA
Potomas	NA	NA	6,286	NA	NA	NA
Skookum	NA	NA	9,440	NA	NA	NA
South Fork Tower	NA	NA	15,840	NA	NA	NA
Spangler	NA	NA	5,710	NA	NA	NA
Squaw	NA	NA	2,580	NA	NA	NA
Tiger Creek	NA	NA	5,566	NA	NA	NA
Upper Tucannon	NA	NA	13,194	NA	8,880	8,650
W-T Three	NA	NA	1,865	NA	NA	NA
Walla Walla River	NA	NA	34,790	NA	NA	NA
Wenatchee Creek	NA	NA	18,910	NA	NA	NA
Willow Springs	NA	NA	9,490	NA	NA	NA
Totals	**NA**	**1,440**	**248,535**	**NA**	**40,074**	31,880

Table 110. Acres of preliminary administratively recommended wilderness areas for each alternative for the Wallowa-Whitman National Forest

Preliminary Recommended Wilderness Areas	Alt. A	Alt. B	Alt. C	Alt. D	Alts. E and F	Alts. E-Mod. and E-Mod. Dep.
Boulder Park	NA	NA	12,930	NA	NA	NA
Castle Ridge	NA	NA	8,780	NA	NA	NA
Dunns Bluff	NA	NA	760	NA	NA	NA
Homestead	NA	NA	2,409	NA	NA	NA
Huckleberry	NA	10,770	10,770	NA	10,770	NA
Hurricane Creek	NA	NA	1,720	NA	NA	NA
Joseph Canyon	NA	NA	6,750	NA	NA	NA
Lake Fork	NA	NA	15,720	NA	NA	NA
Little Creek	NA	NA	2,590	NA	NA	NA
Little Eagle Meadow	NA	NA	6,840	NA	NA	NA
Little Sheep	NA	NA	5,490	NA	NA	NA
Marble Point	NA	NA	3,100	NA	NA	NA
Monument Rock	NA	NA	5,850	NA	NA	NA
Reservoir	NA	NA	15,300	NA	NA	NA
Squaw	NA	NA	3,543	NA	NA	NA
Twin Mountain	NA	NA	57,640	NA	9530	12,020
Upper Catherine Creek	NA	NA	7,020	NA	NA	NA
Wildhorse	NA	NA	289	NA	NA	NA
Totals	**NA**	**10,770**	**172,749**	**NA**	**20,306**	12,020

Table 111. MA 1B acreage for each alternative for each national forest

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alts. E and F	Alts. E-Mod. and E-Mod. Dep.
Malheur	0	1,160	83,810	0	30,400	26,570
Umatilla	0	1,440	248,676	0	40,100	31,880
Wallowa-Whitman	0	10,770	172,840	0	20,300	12,020

Recommended wilderness can affect existing wilderness. Designation of new wilderness may change patterns of recreation use, create larger contiguous areas, and reduce pressure within existing wilderness areas. Opportunities for wilderness-dependent recreation may increase. Motorized use would be prohibited in areas recommended for wilderness designation (except for alternatives B, E, and F—see below for additional discussion). Motorized use (such as motorcycle, all-terrain vehicle, utility vehicle, and full-size vehicle use) would be displaced from recommended wilderness areas. Winter motorized use would be allowed in Management Area 1B in Alternatives B, E and F, but prohibited in Alternative C, E-Modified, and E-Modified Departure. Bicycles (a form of mechanical transport) would be restricted to existing system roads and trails until Congressional designation, and then bicycles, along with other forms of mechanical transport, would be prohibited.

Only Congress can pass legislation to create wilderness, therefore, management area (MA) allocation for recommended wilderness (MA 1B) does not create designated wilderness. MA 1B,

recommended wilderness, protects the characteristics that make the area suitable for wilderness designation. Management strategies for recommended wilderness may affect recreation opportunities and experiences within these areas. Standards and guidelines presented in the draft Plan provide management direction to maintain wilderness area eligibility, and would exclude existing and proposed actions that may compromise the area's eligibility.

Potential wilderness areas (primarily inventoried roadless areas as established by the Roadless Area Conservation Rule) that are not allocated to MA 1B are allocated to other management area designations. Alternative D allocates the most acreage of inventoried roadless areas to management areas that allow activities that may have an impact on existing wilderness characteristics, followed by Alternative B with the second highest amount. Alternatives E, E-Modified, E-Modified Departure, and F are similar and allocate an intermediate amount of acres to management areas that allow activities that may affect existing wilderness characteristics. Alternative C allocates the least amount of acreage to other management areas, and all potential wilderness areas in this alternative would be allocated as recommended wilderness areas. Table 112 through Table 114 and Figure 19 through Figure 22 display the total number of acres of inventoried roadless area that are allocated to varying management areas by each alternative.

Table 112. Inventoried roadless area allocation for affected management areas by alternative for the Malheur National Forest

Management Area Designation and Name	Alt. A	Alt. B	Alt. C	Alt. D	Alts. E and F	Alts. E-Mod. and E-Mod. Dep.
1B Preliminary Administratively Recommended Wilderness Area	0	0	69,200	0	26,900	21,200
2A Wild and Scenic Rivers (includes designated, eligible, and suitable rivers)	7,800	7,900	7,800	7,900	7,800	7,900
2B Research Natural Areas	2,100	2,300	1,900	2,300	2,300	2,300
2C Botanical Areas	0	100	0	0	100	100
2H Scenic Areas	12,400	12,300	2,300	12,300	6,500	12,300
3A Backcountry (nonmotorized use)	40,400	49,800	104,300	0	40,000	39,900
3B Backcountry (motorized use)	13,200	116,000	0	165,800	104,900	104,700
3C Wildlife Corridor	0	0	100	0	0	0
4 General Forest*	112,400	0	2,700	0	0	0
Totals	188,300	188,400	188,300	188,300	188,500	188,400

* Acreage allocated to Management Area 4 resulted from geospatial analysis and is not intended to reassign management direction from existing inventoried roadless area management direction.

Table 113. Inventoried roadless area allocation for affected management areas by alternative for the Umatilla National Forest

Management Area Designation and Name	Alt. A	Alt. B	Alt. C	Alt. D	Alts. E and F	Alts. E-Mod. and E-Mod. Dep.
1B Preliminary Administratively Recommended Wilderness Area	0	0	207,100	0	36,600	29,100
2A Wild and Scenic Rivers (includes designated, eligible, and suitable rivers)	3,500	12,800	6,400	12,800	8,100	10,500
2B Research Natural Areas	7,700	300	0	300	300	300
2C Botanical Areas	300	1,600	100	1,600	1,600	200
2E Historical Areas	100	100	0	100	100	100
2H Scenic Areas	25,000	21,600	9,900	21,600	16,500	22,800
2J Municipal Watersheds	12,500	20,100	20,100	20,100	20,000	19,800
3A Backcountry (nonmotorized use)	19,700	19,200	30,800	0	62,000	42,600
3B Backcountry (motorized use)	14,300	198,900	0	218,700	129,400	148,200
3C Wildlife Corridor	0	0	100	0	0	0
4 General Forest*	191,900	600	700	0	600	800
5 Developed Sites and Administrative Areas	200	100	100	100	100	200
Totals	275,200	275,300	275,300	275,300	275,300	274,600

* Acreage allocated to Management Area 4 resulted from geospatial analysis and is not intended to reassign management direction from existing inventoried roadless area management direction.

Table 114. Inventoried roadless area allocation for each management area by alternative for the Wallowa-Whitman National Forest

Management Area Designation and Name	Alt. A	Alt. B	Alt. C	Alt. D	Alts. E and F	Alts. E-Mod. and E-Mod. Dep.
1B Preliminary Administratively Recommended Wilderness Area	0	10,400	155,700	0	19,900	12,000
1C Wilderness Study Area	2,300	2,300	2,300	2,300	2,300	2,300
2A Wild and Scenic Rivers (includes designated, eligible, and suitable rivers)	8,600	25,600	15,600	12,500	10,300	12,500
2B Research Natural Areas	2,000	2,600	300	2,600	2,600	2,600
2C Botanical Area	0	0	0	0	0	400
2J Municipal Watersheds	0	18,400	18,400	18,400	18,400	18,400
3A Backcountry (nonmotorized use)	0	0	62,200	0	81,200	31,200
3B Backcountry (motorized use)	97,800	194,900	0	219,500	119,500	175,800
3C Wildlife Corridor	0	0	400	0	0	0
4 General Forest*	144,600	1,000	200	0	1,000	0
5 Developed Sites and Administrative Areas	100	100	100	100	100	100
Totals	255,400	255,300	255,200	255,400	255,300	255,300

* Acreage allocated to Management Area 4 resulted from geospatial analysis and is not intended to reassign management direction from existing inventoried roadless area management direction.

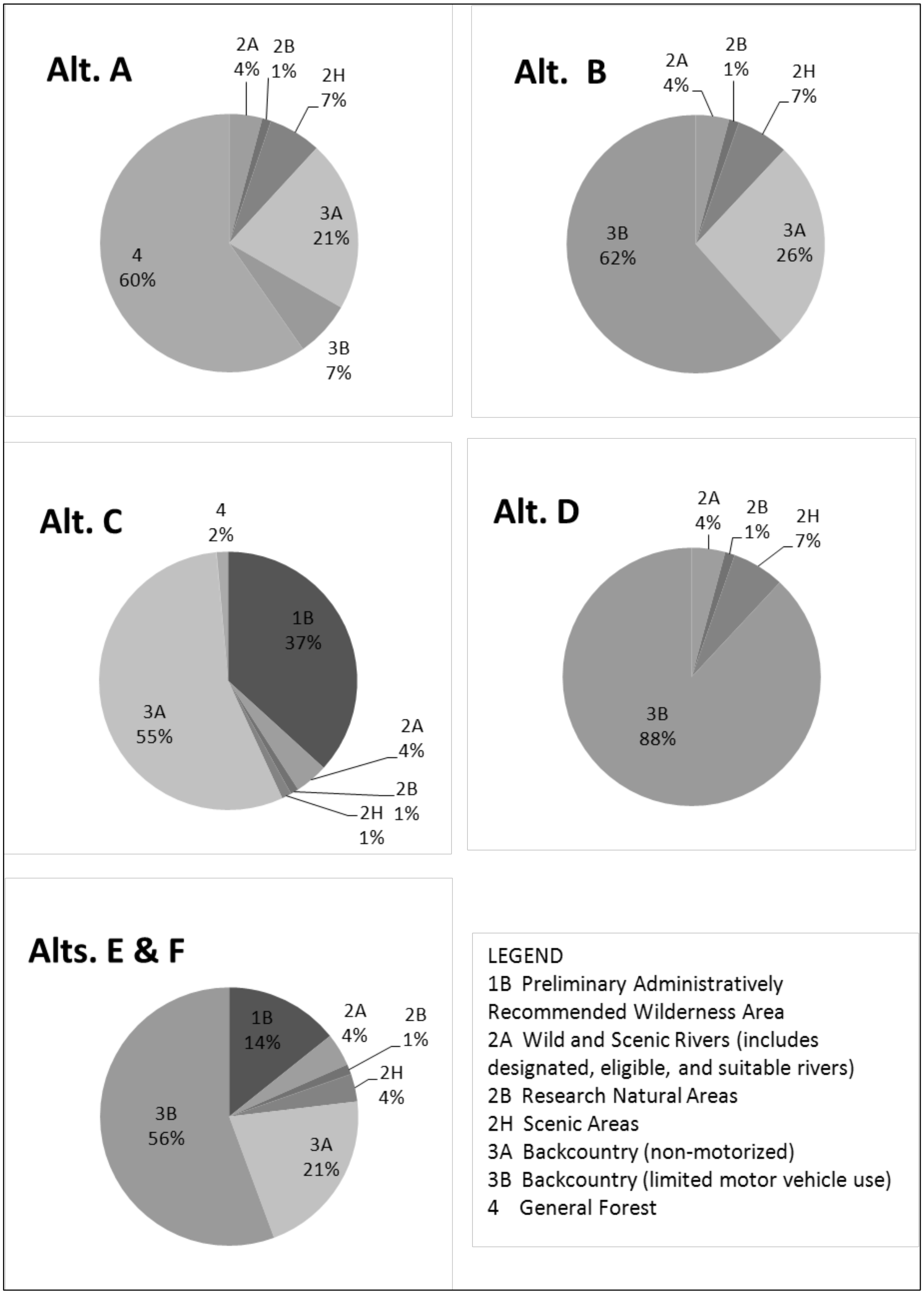


Figure 19. Inventoried roadless area allocation for each management area by alternative for the Malheur National Forest

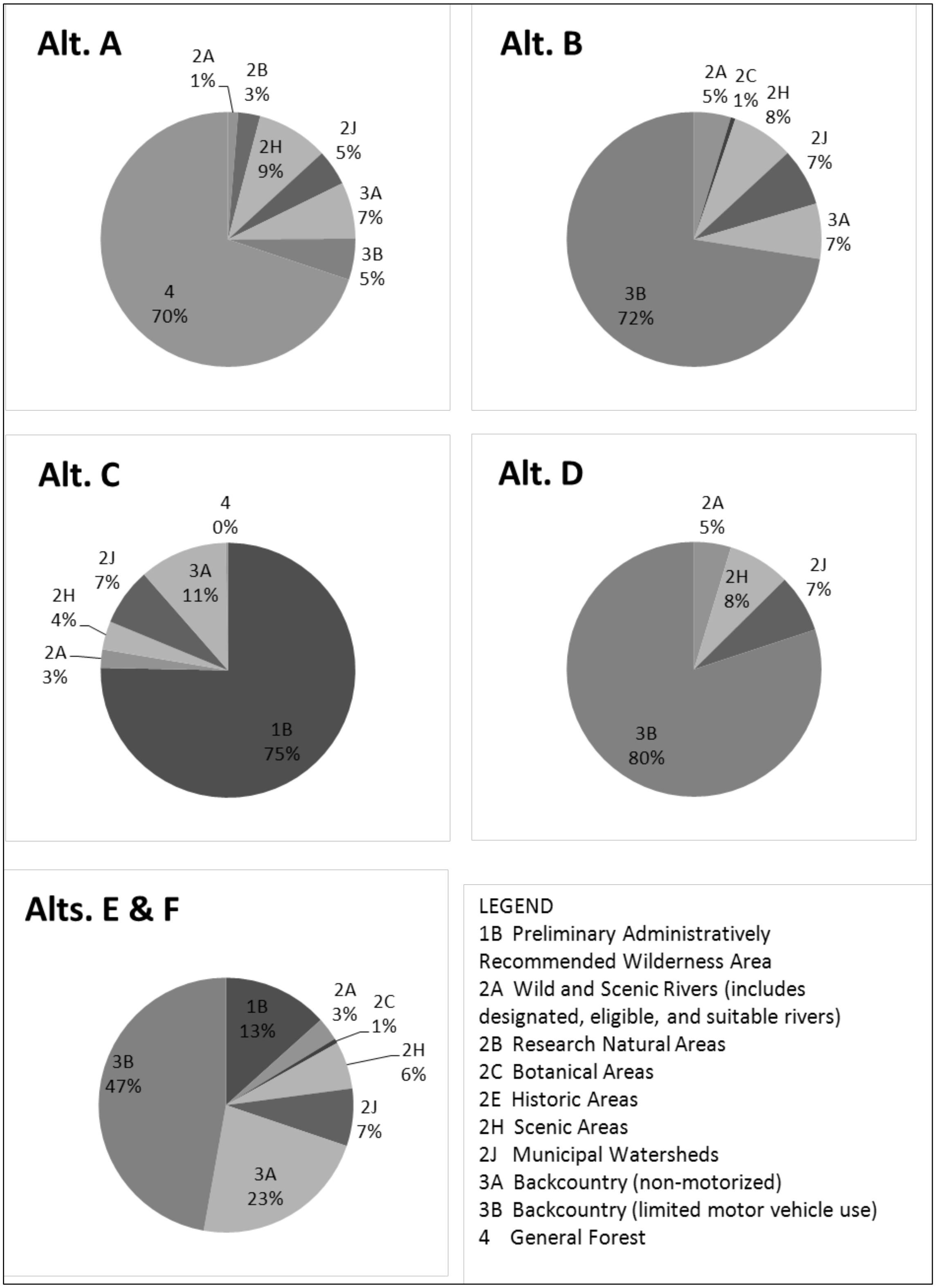


Figure 20. Inventoried roadless area allocation for each management area by alternative for the Umatilla National Forest

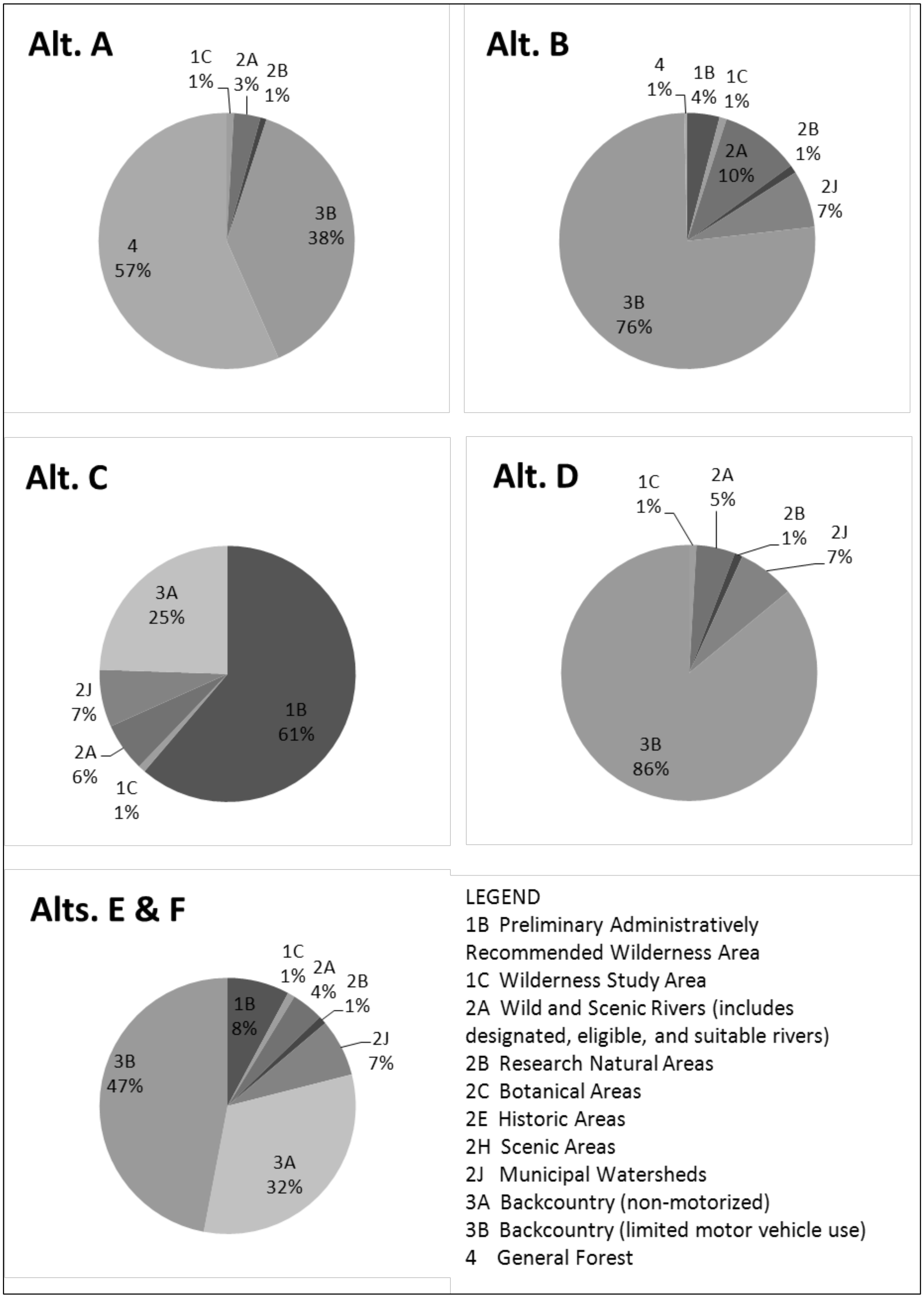


Figure 21. Inventoried roadless area allocation for each management area by alternative for the Wallowa-Whitman National Forest

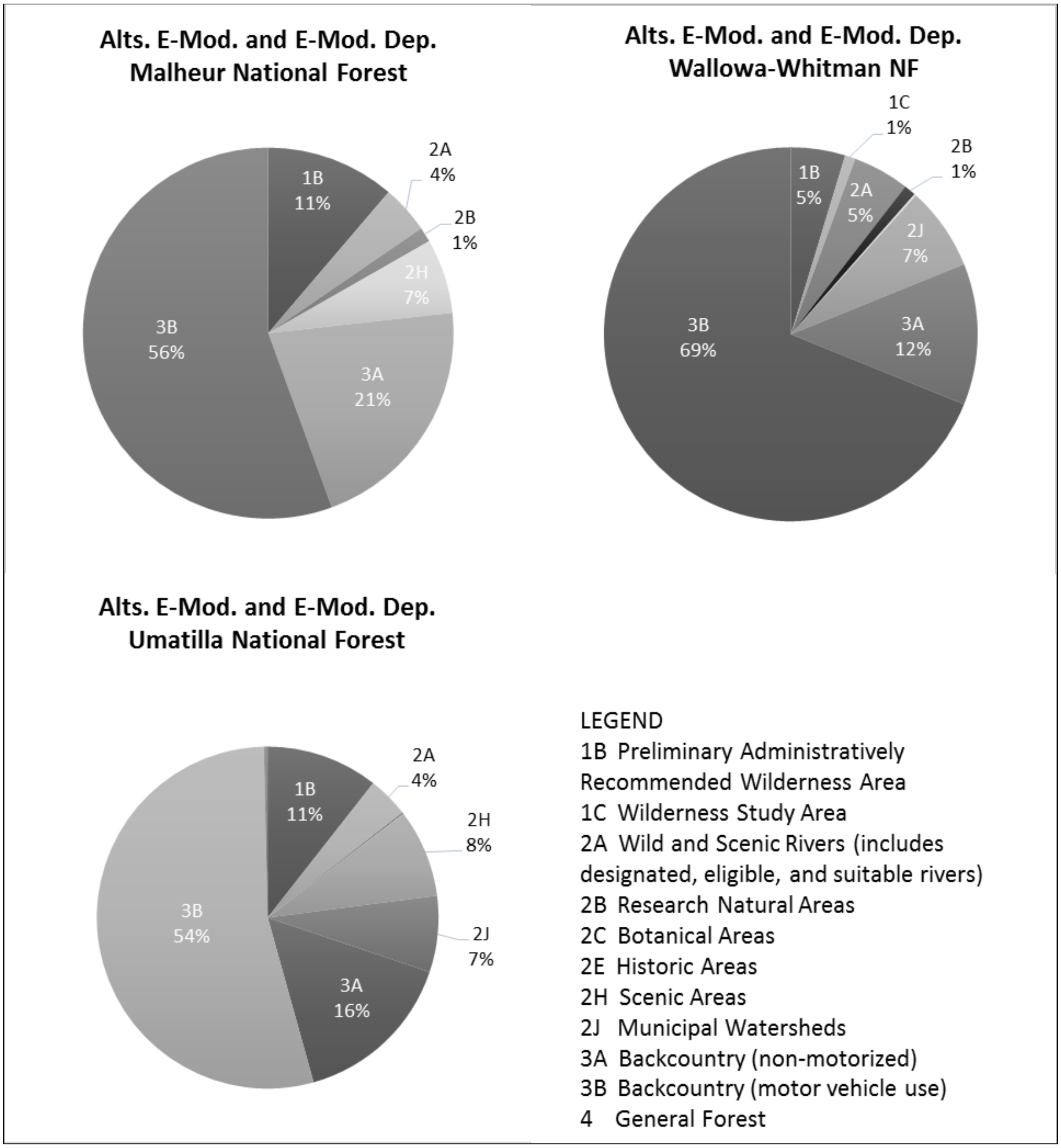


Figure 22. Inventoried roadless area allocation for each management area for Alternatives E-Modified and E-Modified Departure for the Malheur, Umatilla, and Wallowa-Whitman National Forests

Indirect Effects

Preliminary administratively recommended additions to the National Wilderness Preservation System ensure that areas are managed to protect and maintain the social and ecological characteristics that provide the basis for wilderness recommendation.

The Blue Mountains national forests provide recreational activities that range from high adventure self-reliance in the backcountry to driving scenic byways. Expansive wilderness areas provide opportunities for people to experience solitude and adventure in a natural environment. Management Area designations that are adjacent to the wilderness can potentially influence and affect wilderness character. The more acres allocated to more development-oriented management

area designation, the higher likelihood of negative effects to existing wilderness. Conversely, the fewer acres allocated to more development-oriented management area designation, the lower the likelihood of negative effects to existing wilderness.

Nonwilderness uses adjacent to wilderness may have a negative effect on the quality of wilderness recreation experiences. Where roads and motorized activities occur along the wilderness boundary, the incidence of illegal use of motorized and mechanized vehicles in the wilderness may increase. High standard roads close to the boundary provide easy recreation access to wilderness and tend to increase use. As use numbers increase, particularly day use, concentrated use affects physical, biological, and social conditions in the wilderness.

Management areas bordering the wilderness that provide motorized use are more likely to affect wilderness condition and uses. The most highly developed areas (for commodity production or recreation use) are generally management areas 4 and 5. If new development occurs adjacent to any of the existing six wilderness areas, effects could include increased noise, modified landscapes, and motorized trespass.

Effects from Alternative A (No Action)

For this alternative, no proposed administratively recommended wilderness would be allocated to MA 1B, and the percent of designated wilderness is 5 percent for the Malheur National Forest, 22 percent for the Umatilla National Forest, and 21 percent for the Wallowa-Whitman National Forest. The forest plan would not make preliminary administrative recommendations regarding areas suitable for inclusion in the National Wilderness Preservation System. These areas would continue to be managed as part of their current management area allocations, which vary by national forest.

Management direction in Alternative A, as presented in the 1990 forest plans, places an emphasis on the production of wood products and activities allocated to MA 4. Alternative A does not propose any new recommended wilderness areas. Alternative A provides for high levels of commodity production and motorized use. Without additional recommended wilderness, recreational use within existing wilderness may increase because acres managed to provide opportunities for solitude or primitive and unconfined recreation do not increase.

Alternative A allocates the largest amount (acres) of potential wilderness areas to MA 4A. These areas would be managed to meet a variety of ecological and human needs, resulting in an increased potential for forest visitors to encounter other people and observe human activities. This alternative offers the least protection to areas with wilderness characteristics.

Malheur National Forest

For the Malheur National Forest, no new areas would be allocated to MA 1B. The majority of potential wilderness areas identified on the Malheur National Forest are allocated to MA 4 – General Forest (112,400 acres) with lesser acreage allocated to MA 3A – Backcountry (nonmotorized use) (40,400 acres) and MA 3B – Backcountry (motorized use) (13,200 acres). Lands within Management Area 4A often display high levels of management activity and associated roads. MA 3A and MA 3B are characterized by remote settings, allowing for both motor vehicle use and nonmotorized use. Although the areas are considered remote, the area may show signs of past activities. Motor vehicle access to these areas may be restricted seasonally, by route designation, or by area restrictions.

Umatilla National Forest

For the Umatilla National Forest, no new areas would be allocated to MA 1B. The majority of potential wilderness areas identified on the Umatilla National Forest are allocated to MA 4 – General Forest (191,900 acres) with lesser acreage allocated to MA 3A – Backcountry (nonmotorized use) (19,700 acres) and MA 3B – Backcountry (motorized use) (14,300 acres). Lands within Management Area 4A often display high levels of management activity and associated roads. MA 3A and MA 3B are characterized by remote settings, allowing for both motor vehicle use and nonmotorized use. Although the areas are considered remote, the area may show signs of past activities. Motor vehicle access to these areas may be restricted seasonally, by route designation, or by area restrictions.

Wallowa-Whitman National Forest

For the Wallowa-Whitman National Forest, no new areas would be allocated to MA 1B. The majority of potential wilderness areas identified on the Wallowa-Whitman National Forest are allocated to MA 4 – General Forest (144,600 acres) with lesser acreage allocated to MA 3B – Backcountry (motorized use) (97,800 acres). No acres are allocated to MA 3A – Backcountry (nonmotorized use). Lands within Management Area 4A often display high levels of management activity and associated roads. MA 3B is characterized by remote settings, allowing for both motor vehicle use and nonmotorized use. Although the areas are considered remote, the area may show signs of past activities. Motor vehicle access to these areas may be restricted seasonally, by route designation, or by area restrictions.

Effects from Alternative B

For this alternative, the additional acreage allocated to MA 1B would slightly increase the National Wilderness Preservation System total acres should those areas be designated as Wilderness by Congress. The percent wilderness areas and recommended wilderness areas for the Malheur National Forest would remain 5 percent. For the Umatilla National Forest, it would remain 22 percent, and for the Wallowa-Whitman National Forest, it would go up 1 percent to 22 percent. For all three National Forests, the additional acreage in MA 1B is situated immediately adjacent to existing designated wilderness. The additions would expand existing wilderness areas and would not create new, unique wilderness designations.

Alternative B proposes four recommended wilderness areas totaling 13,400 acres. This total is more that Alternatives A and D, but less than Alternatives C, E, E-Modified, E-Modified Departure, and F. Alternative B emphasizes a combination of active management and natural processes for restoring landscapes. In this alternative, four wilderness area additions would be managed to preserve wilderness characteristics.

For this alternative, winter motor vehicle use would continue to be allowed in MA 1B.

Alternative B allocates the largest amount (acres) of potential wilderness areas to MA 3B. This area is managed generally where natural ecological processes predominate, are relatively remote, and may show signs of past activities. Use includes both motor vehicle use and nonmotorized use.

Malheur National Forest

For the Malheur National Forest, the Strawberry Mountain Wilderness Area Additions, comprised of three separate areas totaling 1,160 acres, would be allocated to MA 1B.

The majority of potential wilderness areas identified in the Malheur National Forest would be allocated to MA 3B – Backcountry (motorized use) (116,000 acres) and to MA 3A – Backcountry

(nonmotorized use) (49,800 acres). These management area designations are characterized by a primitive and remote setting and include areas with naturally appearing landscapes and areas that may exhibit signs of past activities. Motor vehicle access to these areas may be restricted seasonally, by route designation, or by area restrictions.

Umatilla National Forest Service

For the Umatilla National Forest, the North Fork Umatilla Wilderness Additions would total 270 acres and the North Fork John Day Wilderness Additions, comprised of two separate areas totaling 1,170 acres, would be allocated to MA 1B. The majority of potential wilderness areas identified in the Umatilla National Forest would be allocated to MA 3B – Backcountry (motorized use) (198,900 acres). This management area designation is characterized by remote setting with both motor vehicle use and nonmotorized use. Motor vehicle access to these areas may be restricted seasonally, by route designation, or by area restrictions.

Wallowa-Whitman National Forest

For the Wallowa-Whitman National Forest, the Huckleberry Roadless Area would total 10,770 acres and would be allocated to MA 1B. The area is immediately adjacent to the Eagle Cap Wilderness and if designated by Congress would expand the existing wilderness. Large portions of the Huckleberry Roadless Area were previously added to the Eagle Cap Wilderness. The previous additions to the Eagle Cap Wilderness in 1972 and 1984 reduced the overall Huckleberry Roadless Area to less than 30 percent of its original area. This alternative would allocate the remaining acres to MA 1B.

The majority of potential wilderness areas identified in the Wallowa-Whitman National Forest are allocated to MA 3B – Backcountry (motorized use) (194,900 acres). This management area designation is characterized by remote setting with both motor vehicle use and nonmotorized use. Motor vehicle access to these areas may be restricted seasonally, by route designation, or by area restrictions.

Effects from Alternative C

For this alternative, a total of 49 new recommended wilderness areas totaling 505,000 acres would be allocated to MA 1B. This would represent an increase to the total acres of the National Wilderness Preservation System should those areas be designated as Wilderness by Congress. The combined percent designated wilderness area and recommended wilderness area within the Malheur National Forest would increase 4 percent for a total of 9 percent or 165,000 acres. Within the Umatilla National Forest it would increase 17 percent for a total of 39 percent or 552,735 acres of wilderness and recommended wilderness. Within the Wallowa-Whitman National Forest it would increase 10 percent for a total of 31 percent or 761,449 acres. If designated by Congress, the additions would both expand existing designated wilderness areas and would designate new unique wilderness areas.

For this alternative, both summer vehicle use and winter motor vehicle use would be unsuitable in MA 1B (see the general suitability matrix table in Appendix A, Volume 4).

Summer motor vehicle use in some locations within the Wallowa-Whitman National Forest would be affected including the Peavine, Evans, Mt Emily, Mt Fanny, Breashears, and portions of the Winom-Frazier motor vehicle trail systems. Nonmotorized use and wilderness characteristics would be enhanced by these changes.

Alternative C proposes 49 new recommended wilderness areas totaling 505,000 acres. This total is more than Alternatives A, B, D, E, E-Modified, E-Modified Departure, and F. Alternative C emphasizes nonmotorized use and the role of natural process in forest restoration. This alternative would allow for the largest amount (acres) of land allocated to MA 1B. This area exhibits primitive qualities and ecosystems are influenced by natural processes with little or no human intervention. Uses are conducive to maintaining the wilderness characteristics of the area.

Alternative C would allocate the largest amount of land that contributes to enhancing the wilderness characteristics of these areas when compared to the other alternatives.

Malheur National Forest

For the Malheur National Forest a total of 9 areas totaling 83,800 acres would be allocated to MA 1B. If designated by Congress, these areas would both expand existing wilderness and would create new unique wilderness designations.

The majority of potential wilderness areas identified in the Malheur National Forest would be allocated to MA 1B and to MA 3A – Backcountry (nonmotorized use) (104,300 acres). These management area allocations are characterized by primitive qualities and retain high levels of integrity regarding wilderness characteristics.

Umatilla National Forest

For the Umatilla National Forest a total of 22 areas totaling 248,500 acres would be allocated to MA 1B. If designated by Congress, these areas would both expand existing wilderness and would create new unique wilderness designations.

The majority of potential wilderness areas identified in the Umatilla National Forest would be allocated to MA 1B and to MA 3A – Backcountry (nonmotorized use) (30,800 acres). These management area allocations are characterized by primitive qualities and retain high levels of integrity regarding wilderness characteristics.

Wallowa-Whitman National Forest

For the Wallowa-Whitman National Forest a total of 18 areas totaling 172,700 acres would be allocated to MA 1B. If designated by Congress, these areas would both expand existing wilderness and would create new unique wilderness designations.

The majority of potential wilderness areas identified in the Umatilla National Forest would be allocated to MA 1B and to MA 3A – Backcountry (nonmotorized use) (62,200 acres). These management area allocations are characterized by primitive qualities and retain high levels of integrity regarding wilderness characteristics.

Effects from Alternative D

For this alternative, no new areas would be allocated to MA 1B, and consequently no increase to the National Wilderness Preservation System would be recommended. The percent of designated wilderness is 5 percent on the Malheur National Forest, 22 percent on the Umatilla National Forest, and 21 percent on the Wallowa-Whitman National Forest. The forest plan would not make preliminary administrative recommendations regarding areas suitable for inclusion in the National Wilderness Preservation System. These areas would continue to be managed as part of their current management area allocations, which vary by national forest.

Similar to Alternative A, Alternative D does not propose any new recommended wilderness areas. Alternative D proposes greater levels of timber harvest than all other alternatives and emphasizes active management to restore the forested landscape. The alternative emphasizes retaining the areas that currently are generally suitable for motor vehicle use, resulting in more area suitable for summer and winter motor vehicle use compared to the other alternatives.

Similar to Alternative B, Alternative D would allocate the most acres of potential wilderness areas to MA 3B. This area is managed generally where natural ecological processes predominate, are relatively remote, and may show signs of past activities. Use includes both motor vehicle use and nonmotorized use. This alternative would contribute the least to wilderness characteristics when compared to Alternatives B, C, E, E-Modified, E-Modified Departure, and F, but would enhance wilderness characteristics more when compared to Alternative A.

Malheur National Forest

For the Malheur National Forest, no new areas would be allocated to MA 1B. The majority of potential wilderness areas identified on the Malheur National Forest would be allocated to MA 3B – Backcountry (motorized use; 165,800 acres). This management area allocation is characterized by remote settings, allowing for both motor vehicle use and nonmotorized use. Although the areas are considered remote, the area may show signs of past activities. Motor vehicle access to these areas may be restricted seasonally, by route designation, or by area restrictions.

Umatilla National Forest

For the Umatilla National Forest, no new areas would be allocated to MA 1B. The majority of potential wilderness areas identified on the Umatilla National Forest would be allocated to MA 3B – Backcountry (motorized use; 218,700 acres). This management area allocation is characterized by remote settings, allowing for both motor vehicle use and nonmotorized use. Although the areas are considered remote, the area may show signs of past activities. Motor vehicle access to these areas may be restricted seasonally, by route designation, or by area restrictions.

Wallowa-Whitman National Forest

For the Wallowa-Whitman National Forest, no new areas would be allocated to MA 1B. The majority of potential wilderness areas identified on the Wallowa-Whitman National Forest would be allocated to MA 3B – Backcountry (motorized use; 215,500 acres). This management area allocation is characterized by remote settings, allowing for both motor vehicle use and nonmotorized use. Although the areas are considered remote, the area may show signs of past activities. Motor vehicle access to these areas may be restricted seasonally, by route designation, or by area restrictions.

Effects from Alternatives E and F

For these alternatives a total of 10 recommended wilderness areas totaling 90,800 acres would be allocated to MA 1B representing a moderate increase to the National Wilderness Preservation System total acres should those areas be designated as wilderness by Congress. The combined percent of designated Wilderness and preliminary administratively recommended wilderness on the Malheur National Forest would increase 1 percent for a total of 6 percent, or 113,000 acres of Wilderness and Recommended Wilderness. On the Umatilla National Forest it would increase 2 percent for a total of 24 percent or 344,274 acres of Wilderness Area and Recommended Wilderness. On the Wallowa-Whitman National Forest it would increase 1 percent for a total of 22 percent or 609,000 acres of Wilderness Area and Recommended Wilderness. If designated by

Congress, the additions would both expand existing designated wilderness areas and would designate new, unique wilderness areas.

For these alternatives, winter motor vehicle use would continue to be permitted within all administratively recommended wilderness areas except for the McClellan Mountain area within the Malheur National Forest, where it is currently prohibited.

Alternatives E and F propose 10 new recommended wilderness areas totaling 90,800 acres. This total is more that Alternatives A, B and D, E-Modified, and E-Modified Departure, but less than Alternatives C. Alternatives E and F emphasize the use of vegetation management and aquatic and wildlife habitat treatments to emphasize active forest restoration.

Alternatives E and F would allocate the majority of potential wilderness areas to MA 3A followed by MA 3B. The distribution is similar to Alternative B for both the Malheur and Umatilla National Forests. These management area allocations are characterized by a primitive and remote setting and include areas with naturally appearing landscapes and areas that may exhibit signs of past activities. Motor vehicle access to these areas may be restricted seasonally, by route designation, or by area restrictions.

This alternative would allocate an intermediate amount of area that contain wilderness characteristics when compared to Alternatives A, B, and D, E-Modified, and E-Modified Departure, but would allocate less when compared to Alternative C.

Malheur National Forest

For the Malheur National Forest a total of three areas totaling 30,400 acres would be allocated to MA 1B. These areas would both expand existing wilderness and create new, unique wilderness designations if designated by Congress.

The majority of potential wilderness areas identified in the Malheur National Forest would be allocated to MA 3B – Backcountry (motorized use; 104,900 acres) and to MA 3A – Backcountry (nonmotorized use; 40,000 acres). These management area allocations are characterized by primitive qualities and retain high levels of integrity regarding wilderness characteristics.

Umatilla National Forest

For the Umatilla National Forest a total of 5 areas totaling 40,000 acres would be allocated to MA 1B. These areas would both expand existing wilderness and would create new, unique wilderness designations if designated by Congress.

The majority of potential wilderness areas identified in the Umatilla National Forest would be allocated to MA 3A – Backcountry (nonmotorized use; 62,000) and to MA 3B – Backcountry (motorized use) (129,400 acres). These management area allocations are characterized by primitive qualities and provide opportunities to protect wilderness characteristics.

Wallowa-Whitman National Forest

For the Wallowa-Whitman National Forest a total of 2 areas totaling 20,300 acres would be allocated to MA 1B. These areas are adjacent to existing wilderness areas and would expand the existing wilderness boundaries if designated by Congress.

The majority of potential wilderness areas identified in the Wallowa-Whitman National Forest would be allocated to MA 3A – Backcountry (nonmotorized use; 81,200 acres) and to MA 3B –

Backcountry (motorized use; 119,500). These management area allocations are characterized by primitive qualities and provide opportunities to protect wilderness characteristics.

Effects from Alternatives E-Modified and E-Modified Departure

For these alternatives a total of 7 recommended wilderness areas totaling 70,500 acres would be allocated to MA 1B representing a moderate increase to the National Wilderness Preservation System total acres should those areas be designated as wilderness by Congress. The combined percent of designated Wilderness and preliminary administratively recommended wilderness on the Malheur National Forest would increase 1 percent for a total of 6 percent, or 109,200 acres of wilderness and recommended wilderness. On the Umatilla National Forest it would increase 2 percent for a total of 24 percent or 336,100 acres of wilderness area and recommended wilderness. On the Wallowa-Whitman National Forest it would increase 1 percent for a total of 22 percent or 384,900 acres of wilderness area and recommended wilderness. If designated by Congress, these additions would both expand existing designated wilderness areas and would designate new, unique wilderness areas.

For these alternatives, winter motor vehicle use would be unsuitable in MA 1B (see the general suitability matrix table in Appendix A). This change would restrict winter motor vehicle use (see the “Access” section for suitability changes by alternative).

Alternatives E-Modified and E-Modified Departure would propose 7 new recommended wilderness areas totaling 70,500 acres. This total is more that Alternatives A, B and D, but less than Alternatives C, E, and F. Alternatives E-Modified and E-Modified Departure emphasize the use of vegetation management and aquatic and wildlife habitat treatments to emphasize active forest restoration.

Alternatives E-Modified and E-Modified Departure would allocate the majority of potential wilderness areas to MA 3B followed by MA 3A. The distribution is similar to Alternative B for both the Malheur and Umatilla National Forests. These management area designations are characterized by a primitive and remote setting and include areas with naturally appearing landscapes and areas that may exhibit signs of past activities. Motor vehicle access to these areas may be restricted seasonally, by route designation, or by area restrictions.

These alternatives would contribute more toward enhancing wilderness characteristics when compared to Alternatives A, B, and D, but would contribute less when compared to Alternative C, E, and F.

Effects Common to Alternatives B, C, E, F, E-Modified, and E-Modified Departure

The areas that would be allocated to MA 1B have been determined to meet the criteria established to qualify for designation as wilderness areas. These areas are preliminarily recommended for designation and inclusion in the National Wilderness Preservation System. Until a decision is made by Congress, these areas will be managed to protect the social and ecological characteristics that provide the basis for recommendation of these lands as suitable for wilderness designation.

Lands allocated to MA 1B within the plan revision alternatives were previously managed as undeveloped lands and generally do not permit activities that conflict with conserving wilderness characteristics. For this reason, there would not be a large shift in management activities or access limitations for MA 1B (with the exception of Alternative C, E-Modified and E-Modified Departure in some locations, see discussion above for winter motorized use restrictions).

Effects Common to Alternatives B, E, and F

For these alternatives, winter motor vehicle use (generally vehicles for over-snow travel, or over-snow vehicle) is determined suitable as displayed in the general suitability matrix in Appendix A. Although long-term physical impacts of over snow vehicle use may be difficult to quantify, winter motor vehicle use does cause short-term physical and social impacts.

Over-snow vehicle use generates biophysical and social impacts. Physical impacts may include effects to wildlife that include increased stress, reduced survival and productivity, impaired immune function, disruption to movement patterns, and changes to behavioral adaptations (Smith 2013). Additional physical impacts include effects to vegetation, soils, and air quality impacts resulting from emissions (Newman and Sears 1999). Social impacts are marked by increased noise and by reduced visual/scenic quality. Over-snow vehicles are often audible across great distances, and tracks in snowfields and high mark play areas may be widespread and affect natural appearance and sense of solitude.

The potential effects that result from over-snow vehicle use in preliminary administrative recommended wilderness areas (MA 1B) include a reduction in the area’s wilderness characteristics, and consequently a reduction in the area’s eligibility for designation and inclusion in the National Wilderness Preservation System. Wilderness recommendations and designation are often controversial, and recent congressional review and findings regarding recommended wilderness areas reveal that areas with reduced wilderness characteristics may be considered ineligible for wilderness designation.

Social Needs and Expectations

Preliminary Administratively Recommended Wilderness Areas (MA 1B) would be unsuitable for timber harvest, summer motor vehicle use (also unsuitable for winter motor vehicle use in Alternative C, E-Modified and E-Modified Departure; see discussion above), road construction, energy development, or mechanical fuels treatment. Limited management activities would be permitted for the purposes of visitor safety and prevention of resource impacts, including invasive species treatment. Grazing would continue as an authorized and permitted activity. Mining would continue. Summer recreation uses that are nonmotorized, including using mechanical transport, such as mountain bikes, would continue.

MA 1B would provide visitors with opportunities for quieter recreation, although in some alternatives, winter motor vehicle recreation would be permitted in some areas. The national forests in the Blue Mountains are currently and will continue to remain popular for recreation activities in areas outside wilderness. Hunting, relaxing, fishing, hiking and walking, gathering forest products, driving for pleasure, viewing wildlife, downhill skiing, and viewing natural features comprise 73 percent of recreational use. Although some of these uses may occur in wilderness areas, none is exclusive to or dependent upon wilderness areas to provide for these activities.

While the Blue Mountains provide high potential opportunities for unconfined recreation experiences and solitude, regionally and locally, the social demand for these unconfined experiences is related to general dispersed settings, not just wilderness, that provide both motorized and nonmotorized activities. From a regional perspective, the national forests of the Blue Mountains are perceived as high opportunities for cultural and spiritual values, historic significance, scenic vistas, hunting, and off-highway vehicle use.

From a forest-level perspective, the recreational users express social values for wilderness areas in numerous ways: solitude for psychological health; un-fragmented forests for habitat and intact landscapes; spiritual uses for solace of open, quiet, beautiful places; for wildlife and pristine settings; and economic opportunities for tourism, hunting, and fishing.

Social values for nonwilderness areas are expressed by recreational users for a variety of reasons: providing a balance of nonmotorized and motorized uses; allowing multiple uses including hunting, fishing, recreation, tourism; and timber harvesting to manage for forest health and to support community economics. Recreational users often express competing or conflicting social values for wilderness and nonwilderness uses for the same places (such as motorized and nonmotorized access; unmanaged and managed landscapes; expansion of recreation trails and limitations on uses). Within the Blue Mountains national forests, there remains a wide variety of opportunities for unconfined outdoor recreation experiences within both wilderness and nonwilderness national forest lands. The desired conditions for MA 1B are provided in Appendix A. The management area maps show the locations of MA 1B for each of the alternatives.

Cumulative Effects

The cumulative effects for the Blue Mountains national forests would be the allocation of National Forest System lands to MA 1B Preliminary Administratively Recommended Wilderness Areas. These lands currently are allocated to other management areas. There are no cumulative effects from Alternatives A and D. In Alternatives B, E, E-Modified, E-Modified Departure, and F, there would be a relatively small number of acres allocated to MA 1B, and in Alternative C, the number of acres allocated to MA 1B would be greatest. Since the areas that would be allocated to MA 1B for Alternatives B, C, E, E-Modified, E-Modified Departure, and F meet the criteria established in FSH 1909.12 Chapter 70 (2007), there would be no change in suitable uses for these areas, except for Alternative C, E-Modified, and E-Modified Departure, which would make winter motor vehicle use unsuitable.

The wilderness characteristics of areas allocated to MA 1B would be protected and enhanced. The degree to which the areas are natural or appear to be natural would be increased through conserving plant and animal species and communities, physical resources, and biophysical processes. The degree to which the area appears to be free from disturbance would be enhanced by reducing actions that manipulate the biophysical environment, and undeveloped quality would improve through reducing structures, installations and developments not related to recreation. Opportunities for solitude or primitive and unconfined recreation would be improved by retaining remoteness and by excluding facilities that decrease self-reliance. Additional qualities including ecological, geological, or other features of scientific, educational, scenic, or historical value would be conserved. Enhancing these qualities would have a beneficial effect on wilderness characteristics and values.

As noted above, lands considered eligible for allocation to MA 1B were previously managed as undeveloped lands and generally do not permit activities that conflict with conserving wilderness characteristics. For this reason, there would not be a large shift in management activities or access limitations for MA 1B. In general, the areas that would not be allocated to MA 1B would be allocated to MA 3A-Backcountry (nonmotorized use), or to MA 3B-Backcountry (motorized use). These backcountry settings would retain many of the social and ecological characteristics that could make them suitable for wilderness designation.

Effects from Other Designations: The cumulative effects analysis area includes all of northeastern Oregon, southeastern Washington, and western Idaho, including all of the Malheur,

Umatilla, and Wallowa-Whitman National Forests, and the time period considered was the planning period. The Hells Canyon National Recreation Area, under the administration of the Wallowa-Whitman National Forest, contains the 217,600 acre Hells Canyon Wilderness. The Hells Canyon National Recreation Area Comprehensive Management Plan, a part of the Wallowa-Whitman National Forest 1990 forest plan, includes protections for the designated wilderness areas, and the area is administered in accordance with the provisions of the Hells Canyon National Recreation Act (Public Law 94-199) and the Wilderness Act. There are no lands within the Hells Canyon National Recreation Area that are allocated to a recommended wilderness management area. All designated wilderness and recommended wilderness areas on all three National Forests would be managed in accordance with laws, regulations, and Forest Service policies and management direction.

Effects from Other Management Areas: Adjacent management activities can have a direct effect on Wilderness and recommended wilderness areas. Gorte (2011) noted that while the Wilderness Act of 1964 does not speak to the issue of buffer zones around wilderness areas, subsequent legislation has prohibited creating buffer zones that would “restrict… uses and activities on Federal lands around the wilderness area.” The first explicit language was enacted in 1980 in P.L. 96-550; section 105 states:

> Congress does not intend that the designation of wilderness areas … lead to the creation of protective perimeters or buffer zones around each wilderness area. The fact that nonwilderness activities or uses can be seen or heard from areas within the wilderness shall not, of itself, preclude such activities or uses up to the boundary of the wilderness area.”

Nearly identical language has been included in 30 wilderness statutes since 1980 (*ibid*). Although subsequent wilderness statutes prohibit wilderness buffer zones, management actions conducted adjacent to wilderness boundaries can affect both management and use of the area inside the wilderness boundary. Areas adjacent to designated wilderness and recommended wilderness that are managed for nonmotorized use are usually more compatible with wilderness management objectives and maintaining wilderness character and quality.

As noted above, management areas bordering designated and recommended wilderness that provide for motorized use are more likely to affect wilderness condition and character. The most highly developed areas (for commodity production or recreation use) are generally MA 4A and MA 5. If new development occurs adjacent to any of the existing six wilderness areas or recommended wilderness areas, effects could include increased noise levels, modified landscapes, and motorized trespass.

Effects from Timber Harvest: The Wilderness Act provides limited timber cutting for mining-related activity, and section (4)(d)(1) specifies that “such measure may be taken as may be necessary in the control of fire, insects, and diseases, subject to such conditions as the Secretary deems desirable.” Vegetation management in wilderness, wilderness study areas, and recommended wilderness is generally restricted to use of wildland fire for multiple objectives in all alternatives. Wildland fire would continue as a possible management technique under all alternatives. Fire suppression measures would be used if and where fuels and weather increase the risk of unwanted fire, either within or emanating from wilderness, wilderness study areas, or recommended wilderness. All alternatives provide for use of wildland fire for multiple objectives in these areas.

Timber harvest activity in areas adjacent to wilderness and recommended wilderness may affect qualities of wilderness character, specifically opportunities for solitude or primitive and unconfined recreation. Vegetation management actions outside of wilderness may affect the remoteness from occupied and modified areas from within the wilderness. Additionally, the natural quality of wilderness character may be impaired through altering plant and animal species and communities in areas adjacent to wilderness, and through an increased potential for the introduction of nonnative species though ground disturbing activities.

Effects from Fire and Fuels Management: While all human-caused fires within wilderness have a management objective of suppression, current and past agency direction allows naturally ignited fires within wilderness and recommended wilderness to be used to accomplish resource benefit objectives including restoring the role of fire in wilderness areas. The Blue Mountains national forests actively manage naturally ignited fires within wilderness to achieve resource benefit. Natural ignitions within wilderness and recommended wilderness areas may also be suppressed to meet protection objectives for values at risk outside of wilderness, or because site specific conditions are unfavorable toward meeting desired resource benefit objectives.

The trend to allow naturally ignited fires to accomplish resource benefits in wilderness and recommended wilderness is expected to continue in the future. All alternatives have desired conditions and objectives that include allowing fire to play its natural role in the wilderness ecosystem. These objectives pertain to both designated and any recommended wilderness. The importance of fire and impacts of fire suppression have long been understood, and naturally ignited fire is recognized as a crucial factor in maintaining naturalness within wilderness (D. Cole and P. Landers 1995).

Impacts resulting from fire suppression activity include possible use of motorized equipment such as chainsaws for fireline construction, helicopters, and application of retardant. Minimum Impact Suppression Tactics are used to minimize suppression impacts to the greatest extent possible while meeting the overall suppression objective.

Restoring natural fire regimes is compounded by the attendant risk to natural and cultural resources, property, and visitors, both within wilderness and on adjacent lands. Fire, in its natural role, can enhance the natural quality of wilderness character. Wildland fire would continue as a reintroduced process in wilderness and recommended wilderness areas under all alternatives, and would have similar effects. Wildland fire for resource benefit increases the natural quality of wilderness character, but may adversely affect visitors' opportunities for solitude. Visitors may encounter sights and sounds of fire management activities like aircraft and other motorized activity, and opportunities for primitive and unconfined recreation may be adversely affected through area closures.

Effects from Livestock Grazing: Commercial livestock grazing is permitted in wilderness by the Wilderness Act of 1964 and in areas designated after 1964, where the activity was established prior to wilderness designation. While being an allowable use, livestock grazing presents nonconforming activities within designated wilderness (e.g. motorized access, structural and nonstructural improvements). Grazing use and management direction within wilderness was further reviewed by U.S. congressional committees in the 95th and 96th Congress (Dawson and Hendee 2009). House Report 96-617 accompanied the Colorado Wilderness Act (P.L. 96-560) providing additional interpretation and clarification regarding the intent presented within Wilderness Act relating to grazing use and activity. The report, often referred to as the "congressional grazing guidelines," "provided for continuation of existing grazing use; the

maintenance and construction of supporting facilities including 'fences, line cabins, water wells and lines, and stock tanks;' and the temporary use of motorized equipment to repair facilities and for emergency purposes" (*ibid*). Livestock grazing, as provided for in The Wilderness Act and subsequent legislation, is an appropriate use of wilderness, where established, and recommended wilderness areas.

Livestock grazing use in wilderness may affect the qualities of wilderness character qualities. Grazing allotments within wilderness are managed to conserve the range resource while observing existing law, regulation, and policy.

Recreational livestock grazing standards and guidelines vary by national forest and are not directly regulated by a permitting process; only livestock used by commercial outfitters and guides is under permit. Standards and Guidelines included in the draft Plan provide a framework for managing recreational livestock grazing use, reducing impacts and influences to desired levels, and maintaining wilderness character.

Effects from Minerals Management: The Wilderness Act of 1964 allows for mining activity within designated wilderness. The use is conditioned by specific criteria outlined within the act and by agency regulations designed to minimize affects to wilderness character. Developing mineral operations within wilderness are generally more difficult and costly and may contribute to the overall absence of development (see the "Mineral Resource" section for leasable minerals, geothermal, coal, locatable minerals, saleable minerals and other energy discussions).

Effects from Recreation and Access: Section (4)(b) of the Wilderness Act states that "wilderness areas shall be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use." Recreation is the most obvious and reported use of wilderness. Though recreation use is a prescribed use within wilderness, visitor and recreational use in wilderness and recommended wilderness has the potential to impair wilderness character or characteristics: naturalness may be affected through impacts to physical resources (e.g. water, soil); undeveloped quality may be affected by recreation related facilities and developments; and opportunities for primitive and unconfined recreation may be affected by facilities that decrease self-reliance and through management restrictions on visitor use.

Section (4)(c), Prohibition of Certain Uses, of the Wilderness Act states that "there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area." While Section (4)(c) prohibits motorized use within wilderness, use of motorized vehicles, equipment, or mechanical transport in areas adjacent to designated or recommended wilderness has the potential to impair the undeveloped quality of wilderness character. Similarly, the opportunities for solitude or primitive and unconfined recreation may be impaired by a decrease in remoteness from occupied and modified areas outside the wilderness.

Issue 6: Ecological Resilience

This section describes the affected environment and environmental consequences related to the ecological resilience significant issue. Concern about the amount, type, and extent of management activities that would be aimed at restoring ecological resilience in the proposed action was expressed during the scoping comment period. Based on perceptions of the current vegetation condition and its resilience, some people think the management approach would be too aggressive while others expressed a desire for a more aggressive approach. The level of public

concern is heightened because the management approach to restoring ecological resilience would determine what ecosystem services the Blue Mountains national forests could provide.

Forest Service policy to reestablish and retain ecological resilience (FSM 2020) was developed after the 1990 forest plans were approved. Resilience is defined as the ability of an ecosystem and its component parts to absorb, or recover from the effects of disturbances through preservation, restoration, or improvement of its essential structures and functions and redundancy of ecological patterns across the landscape. While the foundational policy for the national forests is to achieve sustainable management and provide a broad range of ecosystem services, forest plans determine the management approach by defining objectives, desired conditions, and standards and guidelines and by predicting outcomes.

Changes Made Between the Draft and Final Environmental Impact Statements

Aside from the global changes throughout this environmental impact statement described in the Preface to this document, the following changes were made specifically to this section:

Improvements to the Description of Treatment Effects in Terms of Resilience: The description of harvesting effects that was contained in the Draft Environmental Impact Statement section “Forest Vegetation, Timber Resources and Wildland fire” was moved to this section of the Final Environmental Impact Statement. This discussion was also strengthened to improve clarity and respond to comments questioning the role of various silvicultural treatments in terms of enhancing ecological resilience.

Change in Terminology: The Draft Environmental Impact Statement referred to one of the key indicators as “fire regime condition class departure score.” This Final Environmental Impact Statement refers to this same metric as the “vegetation departure index value.” No changes were made to the way the values were calculated. This change was made to distinguish more clearly to the readers the difference between these values and the related concept of fire regime condition class. Fire regime condition class can be thought of as being a product of two major elements: the condition of the vegetation and also the current characterization of the fire regime itself in terms of frequency and severity. The vegetation departure index values presented here focus solely on vegetation so that the effects of proposed management on structure, age classes and density can be clearly detected. The more comprehensive concept of fire regime condition class is discussed fully in the “Wildfire” section.

Adjustments to Vegetation Departure Index Value Results: Between the development of the draft and the Final Environmental Impact Statements, small rounding errors were detected in some of the departure index results presented in several tables. To more accurately compare alternatives, corrections of 1 or 2 points were made to some values.

Changes to the Watershed Analysis: Revised vegetation data presented in this section and the “Forest Vegetation” section were incorporated into the “Watershed Function, Water Quality, and Water Uses” analysis. Vegetation departure index values were computed for individual watersheds by computing the departure index for each combination of the three National Forest’s potential vegetation groups (dry forest, moist forest, cold forest) and four management strata (general forest, wilderness, roadless, and reserve). The reserve strata includes riparian management areas, but the percentage of the strata represented by riparian areas varies by alternative and is highest in Alternative C and lowest in Alternative D.

Livestock use intensity was recalculated between the draft and final statements to better represent actual livestock use in individual subwatersheds based on revisions of suitable acres for each alternative.

Roads data were recalculated using more recent (2013) data and summed by subwatersheds using the current watershed layer (NHD, or National Hydrographic Dataset).

Ecological Resilience – Affected Environment

Contemporary thinking in ecological theory has largely moved away from the traditional "balance of nature" concept that implies undisturbed nature is ordered and harmonious. Modern ideas tend to view natural systems as normally fluctuating among a wide range of states, all of which represent different phases of what is still fundamentally the same system (Wu and Loucks 1995). Ecological resilience involves the ability of an ecosystem and its component parts to absorb, or recover from the effects of disturbances. More simply put by Holling (1973), it is the largest shock a natural system can absorb before transitioning into a completely different regime. These "shocks" may also occur in the form of slow, continual accumulation of change, until at some point, like the proverbial straw on the camel's back, a threshold is crossed and a fundamental system change occurs (Millar and Stephenson 2015). Examples of these gradually accumulating changes in forest environments may be the slow accumulation of biomass over time, and/or the unrelenting stressing effects of climate change (Wu & Kim 2013; Halofsky & Peterson 2017). If these types of processes or forces continue to accumulate unabated in a forest ecosystem, the system will eventually become fragile to the point where even a small disturbance could trigger an elemental change. For example, if a small relatively benign single tree fire starts during a period of extreme weather within a very dense dry forest that has accumulated an unnaturally high level of fuels, the outcome could be a large-scale severe stand replacing fire that causes natural forest regeneration mechanisms to fail. The result could be a system shift into a semi-permanent shrub or grass land (Chambers et al. 2016; Savage & Mast 2005).

Historically, large areas of the Blue Mountains forests were characterized by disturbance regimes dominated by frequent, low- to moderate-severity wildfire which produced mostly low or moderate-density, uneven-aged stands dominated by large mature trees (Agee 1993; Noss et al. 2006; Reynolds et al. 2013). Since the arrival and settlement of Euro-Americans in the early 1800s, the Blue Mountains have experienced significant changes brought about by highly effective fire prevention and suppression, widespread sheep and cattle grazing and livestock fencing, development of extensive road and railroad networks, subdivision of regional landscapes by ownership, large-scale and repeated timber harvest including selective cutting of the largest and most fire, drought and insect/disease resistant tree species. As a result, today these forests neither resemble nor function as they once did 100 or 200 years ago (Stine, et al. 2014). The current state of the forest and rangeland vegetation, and the ramifications of these changes are analyzed in more detail in later sections of this document, but some key changes are outlined below. The nature of these changes along with possible restoration strategies and barriers have been outlined in recent years by several forest scientists and ecologists including Stine et al. (2014), Hessburg et al. (2015), Hessburg et al. (2016), Franklin et al. (2014), Haugo et al. (2015), and Franklin and Johnson (2012). Some of the key changes that have developed, particularly within the dry upland forests and moist upland mixed conifer forests, include:

- Creation of a simplified landscape vegetation mosaic dominated by a surplus of dense young and mid-aged forests and a lack of old mature forests.

- A shifting of tree species composition away from species that are naturally the most resistant to disturbance agents like fire, drought, and insect/disease outbreaks.
- An increased vulnerability to large and severe fires, insect outbreaks, and disease.

The natural capacity of many of these natural systems to rebound is now coming into question as large areas of the Blue Mountains are being negatively impacted by years of drought and by forest diseases and insect outbreaks. They are also often uncharacteristically overloaded with fuel loads, which sets them up for unusually severe and extensive wildfires. There is concern that as areas are affected by these disturbances, they may not rebound as quickly as they were able to historically. Similarly, there is concern that eventual recovery trajectories may not be along desirable pathways, and as a result the provision of ecosystem services could be disrupted for much longer amounts of time than normally required for forests to revegetate.

The Forest Service estimates that nationally there are between 65 and 82 million acres of National Forest System lands in need of restoration to address decades of fire suppression and the associated buildup of hazardous fuels, insect mortality, the effects of historical harvest practices, invasive species and the effects of climate change (USDA Forest Service 2012). Within this region, Haugo et al. (2015) identified over 1.7 million acres of National Forest System lands within the Blue Mountains region that were in need of some sort of restoration to return forest structures to a natural condition. The “Forest Vegetation,” “Wildland Fire,” and “Old Forest” sections of this document quantify in detail the degree of deviation from historical conditions in terms of vegetation and fire regimes. There is growing concern about the ability of these forests to continue to absorb and recover from future disturbances. This has led to a general increase in support for forest restoration, and consequently, the Forest Service is currently placing renewed emphasis on increasing the pace of restoration within the limits of its multiple-use mandate to ensure the resiliency of forest and range ecosystems (USDA Forest Service 2012; USDA Forest Service 2016).

The need for restoration of forests like those found in the Blue Mountains is widely recognized, but is not accepted by all forest scientists. In recent years some scientists (Hanson et al. 2009 and 2010, Baker 2012, Williams and Baker 2012, Dellasala and Hanson 2015, Odion et al. 2014, and Baker 2015), have disputed the need for large-scale forest restoration or fuels reduction within the pine and mixed conifer forests of the Inland West. Authors such as those cited provide evidence that current large patches of high-severity fire may be within the historical range of variability for these forests, and suggest that the risk of loss for dense multistoried forest to high-severity fire is relatively low. They also suggest that widespread and ecologically important changes have not occurred in these forests in the last century and that restoration activities on any substantial scale are unjustified.

Conversely, Hessburg et al. (2016) state in their conclusions that inferences by the above noted authors are based on vegetation reconstructions using General Land Office or Federal Forest Inventory and Analysis data. Hessburg et al, (2016) further point out that while data from those sources are useful for general descriptions and tabulations of historical vegetation conditions, they may be poorly suited to making spatially accurate inferences for local historical vegetation conditions, and/or for inferring disturbance regimes from size distributions of trees.

Certainly in some cases, perhaps where a watershed is currently well functioning and resilient, an argument could be made for a passive, “hands-off” approach to management. Within a large portion of the national forests, a history of fire suppression and other legacy effects of past management has led to conditions that will necessitate a more active approach to restore more

natural conditions (USDA Forest Service 2012). An analysis of restoration needs by Haugo et al. (2015), shows that only a minority of the Blue Mountains forest lands currently in need of restoration will be likely to recover through passive natural succession alone. The vast majority will need either active intervention or a combination of active intervention followed by additional successional development to return to some semblance of natural forest structural conditions.

Management treatments that could be used to actively restore the structure and composition of these forests in order to foster more resilient conditions would include mechanical thinning (both commercial and precommercial), even-aged and uneven-aged regeneration harvesting, tree planting, prescribed burning and/or managed wildfire. More detailed descriptions of these treatments along with more information on how they function as restoration treatments can be found below in the "Environmental Consequences" section.

The national forests of the Blue Mountains encompass parts of 10 major river basins that are tributaries to either Snake or Columbia Rivers and parts of 25 hydrologic subbasins. The context in which forest vegetation conditions influence watershed conditions, and the role that vegetation plays in regulating watershed runoff is described in different parts of this text. For the purpose of this analysis, watershed conditions are a function of vegetation conditions, riparian conditions, hydrologic conditions, and stream channel conditions, as affected by historic and ongoing land use. Additional details are provided in the "Watershed Function, Water Quality, and Water Uses" section of this document and in the description and rationale for use of individual indicators in this section.

This issue influenced the development of the alternatives, which include varying levels of restoration activities and resulting outcomes. The six indicators described below reflect the relative differences between alternatives and the degree to which each alternative is designed to maintain or restore ecological resilience. The alternatives predicted to make the most progress towards achieving the desired conditions would also be the alternatives that restore the highest level of resilience.

Key Indicators to Reflect the Level of Management Activity

- Annual forested vegetation active restoration activities (acres)
- Road treatments in priority watersheds (miles)
- Forage use in priority watersheds (intensity)
- Improved riparian areas (miles)

Key Indicators to Reflect Resilient Conditions

- Watersheds in improved conditions
- Improvement in the dry upland forest potential vegetation group departure index values at year 50

Ecological Resilience – Environmental Consequences

Objectives and Design of the Alternatives

All planned activities (timber harvest, reforestation, mechanical fuels treatments, wildfire management and prescribed fire) would have the following general ecological objectives: to maintain or improve ecological resiliency, stand structures, species composition, stand densities, landscape patterns, fire regime condition classes, and potential fire behavior. These activities are

designed to move the landscape towards the desired conditions for vegetation. The activities include social objectives to protect critical resources, such as municipal watersheds, wildland-urban interface areas, and adjacent private property. Economic objectives include contributing to the maintenance of community infrastructure, such as lumber mills and ranches.

Effects of Harvest and Other Restoration Treatments Common to All Alternatives

The following discussion describes the harvest and stand management prescriptions common to all alternatives and how those treatments would create positive changes in terms of ecological resilience. The potential negative side effects of harvesting and other forestry treatments are addressed in the sections of this document addressing soil, water and wildlife resources.

Most of these forestry techniques of stand-tending and regeneration were developed as part of classic silvicultural systems which were originally designed primarily to produce and harvest mature crops of timber products (Smith et al. 1997). Modern approaches to forest management also now view timber harvest and other silvicultural techniques as restoration tools that can be used to modify stand structures, species composition, stand density, landscape patterns, and potential fire behavior. This approach is sometimes referred to as "ecological forestry," as it attempts to fully incorporate an understanding of natural disturbance and stand development processes (Franklin et al. 2007). This greater understanding of disturbance processes and how they relate to ecological resilience has led to silvicultural treatments increasingly being designed as forms of disturbance emulation that are meant to help restore ecosystem processes in addition to producing forest products (O'Hara and Ramage 2013). This concept of using forest management to emulate natural disturbance has been discussed within a growing body of science literature and is often recommended as a technique to restore resilient forest conditions (Mitchell et al. 2002; Sarr 2004; Drever et al. 2006; Long 2009; Geldenhuys 2010). The ways of artificially imitating disturbances can range from actually incorporating controlled forms of the disturbance into a treatment (such as prescribed fire), to designing harvest or thinning prescriptions that purposely try to leave conditions similar to those found after natural disturbances, such as reserved legacy trees and mosaics or patches of trees left on the landscape.

Thinning Effects

In forestry, the term "thinning" encompasses a wide range of treatments, but fundamentally they are all considered intermediate treatments (that is, they are not meant to result in a need for reforestation). These treatments are made to reduce the stand density of trees primarily to improve growth, enhance forest health, recover potential mortality, alter tree species composition, or manage understory conditions. If the trees removed can be used as some form of forest products, the thinning is typically referred to as "commercial thinning" harvest. If the trees removed are generally too small to be harvested commercially or provide for immediate financial return, then the thinning is referred to as "precommercial."

Natural thinning or competitive mortality results from the fact that as trees grow, they occupy more growing space and compete for limited resources. The common "low" thinning, or thinning "from below" treatment imitates this competitive mortality by removing mostly the smaller trees which are the ones that tend to naturally die first. Other types of thinning can be designed to emulate disturbances that would cause small-scale canopy mortality like insects, root disease, or low to moderate severity fire behavior would. Thinning as a traditional forestry tool is fundamentally a density management technique that manages the trade-offs between stand-level productivity and individual tree vigor (Long 1985). The direct effect of thinning treatments is lower stand densities, which results in increased vigor and growth among the residual trees.

Thinning can also be used to support restoration objectives related to ecological resilience such as moderating potential fire behavior, increasing resistance to insects and diseases, altering species composition, converting multi-storied stands to single-storied structures and increasing the proportion of low density, or open canopy stands on the landscape.

Thinning treatments used in the alternatives would support desired conditions which look for low to moderate levels of susceptibility to insect and disease disturbance. The vigor of trees and their ability to defend themselves against attack or infection is linked to stand density. High stand density levels spread the available site resources among too many individual trees. The result is that many trees decline in vigor and become stressed. Stress reduces the ability of trees to resist insects and diseases and increases the likelihood of mortality. Thinning has been shown to be a useful means of reducing the likelihood of mortality associated with many common species of bark beetles that play major roles in the forests of the Blue Mountains. It may also help reduce the potential for damage from root disease (Fettig et al. 2007; Filip, et al. 2007). Thinning from below may mitigate the potential impact from defoliators by reducing the multi-storied structures in which some species tend to thrive (Brookes et al. 1987).

Thinning treatments as used in these alternatives would also be designed to directly alter the species composition within stands by deliberately targeting undesired species for removal and giving retention priority to underrepresented desirable species. Increasing tree species diversity in this way helps to increase resilience to insect outbreaks, particularly in low-diversity stands (such as stands where ponderosa pine and western larch were removed and largely supplanted by grand fir) (Dymond et al. 2014). In addition to being very susceptible to root disease, the grand fir that currently dominates much of the area is particularly susceptible to fir engraver beetles and two common species of defoliating insects. Stand susceptibility to these threats increases as the proportion of host species increases. Therefore, reducing the proportion of these hosts in favor of non-hosts or less susceptible species will likely reduce the potential for undesired impacts. Promoting a mixture of species through thinning would increase the resilience of stands by mitigating the risk that any single type of insect or disease agent is capable of causing severe damage to an entire stand or over a broad-scale area.

Managing species compositions with treatments like thinning can also be used to increase the resilience of an area to wildfire disturbances. One of the greatest factors limiting a forest's ability to recover following a wildfire is the presence of a viable seed source in the form of surviving residual trees. Since ponderosa pine or larch are among the most fire resistant species, favoring these species for retention in a thinning prescription will increase the likelihood that a seed source will survive the wildfire and remain available to facilitate rapid recovery in the future.

Thinning treatments would also be commonly used to directly mitigate the potential severity of future fire behavior. Many fire and fuel managers now recognize that the most effective objectives for fuel treatments in terms of promoting resistance and resilience to fire are not centered on suppression. Much of the focus today in restoration and fuels management is about creating conditions in which fire can be allowed to occur without resulting in severe negative consequences (Reinhardt et al. 2008). Objectives such as this support resiliency by making a forest more capable of maintaining substantial live basal areas after a wildfire has occurred. Structural changes created by thinning treatments would support these objectives by:

1. decreasing the density of fuel in the canopy which makes lethal crown fire less likely;
2. reducing ladder fuels below the canopy which lessens the probability of initiating crown fire;

3. reducing surface fuels, which reduces flames lengths and promotes relatively benign surface fire behavior; and
4. retaining large trees of the most fire resistant species (Agee & Skinner 2005).

A recently completed systematic review of scientific studies evaluating the effectiveness of fuels treatments found strong evidence that thinning treatments, particularly when combined with prescribed burning, were effective at meeting goals related to reducing fire severity (Kalies and Yocum Kent 2016).

Two potential negative consequences of thinning practices in terms of restoring ecological resilience that have been raised include increased uniformity of forest structure, and removal, or delay in the development of snags or down wood to meet habitat needs (Anderson 2013). However, a thinning prescription could be specifically designed to avoid these problems by deliberately incorporating techniques to promote variable densities, skips and gaps, retention of minor species and snags, or even active creation of snags and down wood (Franklin et al. 2007; Churchill et al. 2013).

Thinning might also lead to adverse consequences if used inappropriately as a one-size-fits-all solution, or as part of a management regime that fails to recognize the need to eventually regenerate forest stands. If applied in the wrong circumstance or within an inappropriate forest type, it could actually decrease the ecological resilience of an area or result in increased insect hazard rather than act as a mitigating action. For example, some forest types, like spruce-fir, are prone to wind-throw when thinned aggressively. In this example, an improperly designed thinning prescription could result in a stand being severely impacted by a windthrow event. Large quantities of recently wind-thrown Engelmann spruce trees often then become ideal breeding grounds for spruce bark beetles and create conditions conducive to epidemic outbreaks (Alexander 1986). Ultimately, the effectiveness of thinning treatments to promote ecological resilience would depend on the specific characteristics of the affected forest types, as well as many project-level decisions regarding operational aspects of the treatment, and other related management activities.

Even-aged Regeneration Harvest Effects

Even-aged harvesting treatments are those that entail a planned sequence of treatments designed to maintain and regenerate a forest stand with predominately only one age class. Common applications of the system in forestry that might be expected to be used within the Blue Mountains include clearcuts, seed-tree and/or shelterwood. Clearcutting removes essentially all trees at one time, producing a fully exposed microclimate for the development of a new age class. This creates a regeneration need which is usually met from either natural seeding, sprouting, or planted seedlings. With the seed tree method a small number of trees are left specifically to provide a natural seed source. The shelterwood method is similar to the seed tree method, except the trees that are left uncut are expected to also moderate or “shelter” the microclimate environment of regenerating stand.

Even-aged regeneration treatments fit into the concept of emulation of natural disturbance as surrogates for severe or stand replacing disturbances. These techniques can also be designed and utilized to mitigate impacts from disease agents like dwarf mistletoe or root fungi. When implemented in their purest forms, centered solely about timber production goals, these types of treatment have been criticized by some forest scientists for not providing enough biological complexity, and not retaining enough live and dead trees as critical habitat elements to be carried over into the regenerating stand. However, these techniques could be adapted to support resilience

goals by incorporating explicit objective levels for retention of both live and dead trees. The resulting regenerated young stands would contribute to age class diversity at the landscape scale. Swanson et al. (2011) have noted that the ecological importance of early-successional forest ecosystems has received little attention, and they tend to be undervalued. A landscape mosaic that contains an appropriate amount and arrangement of stand initiation structure stages would support resilience by breaking up large continuous areas of heavy fuel loads and reducing the potential contagion and spread of insects and diseases.

Uneven-aged Management Harvest Effects

Uneven-aged harvesting (also referred to as multi-aged management) involves developing a planned sequence of treatments designed to regenerate or maintain a stand containing three or more distinct age classes. Typical methods include either single-tree selection or group selection. Single-tree selection is where individual trees of all size classes are removed during harvest in an effort to move toward some designed target structure. To some extent, the purpose of the harvesting is to promote growth of remaining trees, but most importantly, to provide space for regeneration and create a new age class. Group selection is similar, except trees are removed from within a stand, not individually, but in small groups or clumps, and new age classes are established within those vacated areas. Both of these practices were originally designed to simulate individual tree or gap-based disturbance regimes. Uneven-aged harvesting strategies implemented by the alternatives would replicate some of this complexity and integrate some aspects of smaller scale disturbance into managed areas of the forest.

The development of multiple tree species within stands as a result of uneven-aged management could promote increased resistance and resilience to species-specific insects or diseases. Single-tree selection cutting would reduce stand densities and canopy cover, thereby it could be designed to favor the growth of shade intolerant species such as ponderosa pine and western larch. A group selection system or a single-tree selection system managed within a low-density regime would support continual regeneration of these more shade-intolerant species in the understory where seed sources are available and/or where gaps and openings are created. Fill-in tree planting would also be used to deliberately manipulate species composition. Regeneration of underrepresented shade-intolerant tree species would support the achievement of the desired conditions for species composition and structural stages, especially within the dry upland forest potential vegetation group.

Uneven-aged management is often overlooked as a method to support fuels management and fire behavior objectives, because the resulting multi-layered structures are thought to pose greater risk of torching and crowning fire behaviors. However, in many areas of the Blue Mountains forests, density management objectives and the lack of old forest single-storied structural classes, calls for managing for relatively open conditions. Multi-aged methods that incorporate low density objectives would alleviate many of these potential concerns from a fuels management perspective. Roloff et al. (2012) demonstrated with simulations and field data that, if properly designed, these types of prescriptions can support multi-aged and old forest attributes while still resulting in forest structures that are resistant to crown fire. The tremendous flexibility available within the full suite of uneven-aged management would offer some forms of resistance and resilience that are not necessarily available under even-aged management or more simple forms of thinning harvesting (O’Hara and Ramage 2013).

One of the strongest ecological effects these multi-aged stands would support is in terms of resistance to disturbance effects (O’Hara & Ramage 2013; O’Hara 2006). The complex residual

stand conditions would typically contain several different age classes as well as a variety of spatial patterns and canopy layers. These conditions would tend to ensure a diversity of means to resist the effects of many disturbance events. The development or establishment of multiple tree species would also specifically enhance resistance to the stand-level resistance to host-specific insects or diseases. These resistance attributes of stands managed with uneven-aged techniques would in turn support resilience by ensuring that essential features of the stands remain, thereby facilitating recovery to a pre-disturbance state (O'Hara and Ramage 2013).

Salvage Harvesting Effects

The Forest Service definition of salvage harvesting is the removal of dead trees or trees being damaged or dying due to injurious agents other than competition; to recover value that would otherwise be lost. The practice of salvage harvesting has been conducted for many decades in the National Forests of the Blue Mountains, and is likely to continue to varying degrees under most alternatives.

The ecological concerns raised about salvage harvesting typically involve effects to soils, terrestrial wildlife, riparian systems and aquatic ecology (Peterson et al. 2009). The potential effects to these resource areas are discussed within other sections of this Final Environmental Impact Statement. The focus here is in terms of salvage harvesting's relationship to ecological resilience, specifically implications to forest regeneration and fuels management. In summary, rather than there being an invariant set of effects inherent to salvage logging, it is more likely that the effects of salvage harvesting will be very dependent on the nature of the disturbance event itself, combined with the type of forest that was affected. The ultimate outcome will also depend on many project-level, site specific decisions that would govern how much of the mortality is salvaged, the manner in which salvage is conducted, and what associated management activities would also occur (Keyser et al. 2009).

In addition to capturing the economic value of the affected timber, the view that post-fire salvage harvesting diminishes fire risk via fuel reduction has been cited in the past as a reason to pursue salvage harvesting after disturbances (Poff 1989). Historically, in most of the dry upland forests of the Blue Mountains, the accumulation of large woody debris was naturally limited by the frequent fires that occurred and consumed most downed wood (Agee 2003; Skinner 2002). However, when a severe or stand replacing fire occurs on today's uncharacteristically dense dry upland forests it would likely leave behind such high levels of woody debris and fuels that without treatment or removal, it would be difficult to reintroduce natural low-severity fire to the recovering forest (Peterson et al. 2009). A salvage harvest prescription that was properly designed to accomplish fuels mitigation objectives could help reduce the risk of uncharacteristically severe fire re-occurring in these sites in the near or mid-term and thus, help return these areas to a more natural low severity fire regime.

An alternate view maintains that post-fire logging may actually exacerbate fuel loads by substantially increasing both fine and coarse downed woody fuel loads (Donato et al. 2006). Salvage harvesting's most direct effect on fuel loads would be in removing the large diameter tree boles from the system. And it is possible that salvage logging could consequently create a short-term pulse of elevated surface fuels by transferring the woody debris in tree branches and tops from the canopies of fire-killed trees to the forest floor. However, this period of relatively elevated hazard within salvaged areas compared to unsalvaged areas tends to be rather short-lived. Deposition and accumulation of surface fuels from decaying snags in unlogged stands would have a tendency to catch up to, and eventually exceed the levels found in logged stands

within 5 to 10 years after the wildfire (Keyser et al. 2009, Ritchie et al. 2013). Also, the effect of increasing surface fuels by salvaging could easily be avoided by deliberately applying associated follow-up fuels treatments, and/or relying on harvest operations that used whole-tree yarding systems that do not result in such high levels of scattered slash.

The intensity of the salvage harvesting would typically depend on the proportion of the stand that is affected by the damaging agent. If salvage cutting is heavy enough to require regeneration, it would be considered a regeneration harvest, and the National Forest Management Act requirements for regeneration harvesting would apply. The natural regeneration responses of forests affected by severe disturbances depend largely on what type of disturbance occurred and what types of trees were present before the event. Some tree species like lodgepole pine or aspen are adapted to be resilient to events like wildfire or insect epidemics, and they can usually recover themselves by sprouting, or from opening serotinous cones. In cases like these, post-disturbance recovery of these resilient systems through natural tree regeneration could potentially be negatively affected by the physical damage caused by salvage harvesting, if salvage operations do not take place until after natural regeneration has become established (Donato et al. 2006).

Other types of forests, like those characterized by species like ponderosa pine, Douglas-fir, and western larch, are designed to resist fire’s effects with their thick bark and lack of low hanging branches. Many areas of the Blue Mountains national forests were historically dominated by these fire-adapted species, which naturally existed within a low-severity fire regime. These types of forest systems primarily rely on mature seed-trees surviving the fires in order to regenerate the post-disturbance site, and thus they are poorly equipped to recover if all potential seed-trees are destroyed. Where severe disturbance destroys all the trees within forests that have evolved to cope with low-severity fire regimes, regeneration and recovery may be delayed for a very long time because the natural seed source has been removed beyond any probable seed dispersal distance (Chambers et al. 2016; Savage & Mast 2005).

In these situations, if properly planned and managed, the surface disturbance typical with salvage harvesting can produce excellent results in terms of site preparation for tree planting. In other cases, the destruction of some or most of the pre-existing regeneration by salvage logging may be a desired objective, as a method of suppressing an unwanted species like lodgepole pine, to promote the establishment of more fire and insect resistant species like larch. Salvage harvesting in areas that seem unlikely to experience prompt natural forest recovery can also provide a funding source for future tree planting or other artificial regeneration methods outside of the areas that are actually salvaged.

Tree Planting Effects

Tree planting is a method of regenerating a forest area by directly transplanting nursery grown seedling stock. Planting of tree seedlings could occur in areas that have been reduced below the minimum desired tree density by timber harvest, insects, disease, or fire, as well as for species composition management and other reasons. Post-fire planting efforts are currently the most common application of these treatments. The most direct contribution of tree planting toward ecological resilience is counteracting potential regime shifts that might otherwise occur. For example, if an uncharacteristic severe stand-replacing fire occurs within a dense forest that is not naturally adapted to recover from high-severity fire, its natural regeneration mechanisms may fail and the system may shift into a semi-permanent shrub or grass land (Chambers et al. 2016; Savage & Mast 2005). This scenario most often occurs when all of the natural seed source is removed from a relatively large expanse of dry upland forest following high severity fire.

Depending on the specific land management objects of the affected area, such a long-term shift may be considered acceptable. In other cases a management activity like tree planting may be used in an attempt to respond to these changes.

Swanson et al. (2011) express concern that tree planting can effectively limit the duration of these important early successional stages by artificially accelerating the progress toward mid-aged structures. (). Tree planting activities do have the potential to accelerate stand development in this manner. Whether this change is considered to be beneficial or not would depend largely on the specific land management objectives of the affected areas. For example, tradeoff(s) may be desirable in areas where competition with brush is likely to inhibit reestablishment of tree species, and management objectives call for promoting mature fire-adapted forest structures and producing desired forest products.

Planting treatments also would support restoration goals by providing an opportunity to directly adjust the future species composition of the new forest stands. This direct opportunity to manipulate tree species and genetic resources is particularly important when confronting invasive diseases such as white-pine blister rust, which affects trees such as whitebark pine and western white pine in the Plan Area. Tree planting may include partially or fully resistant genetic stock which would help meet management objectives by supporting the maintenance of species that are threatened by invasive species.

Watershed Effects

Watersheds in the Blue Mountains vary in location, size, elevation, vegetation cover, and soils. These differences affect the amount of precipitation that individual watersheds receive, the amount of precipitation that occurs as snow, and the amount of precipitation that is converted to streamflow. Precipitation is the largest component of the water budget of individual watersheds. At lower elevations, a higher percentage of precipitation falls as rain that is transported through watersheds within hours or days after rainfall. At high elevations, most precipitation in winter falls as snow that accumulates in winter months and melts in spring and summer over a period of several weeks to months. Forest soils are a reservoir for water storage in which water moves downslope under the influence of gravity and is depleted by evaporation or by transpiration through live vegetation. The combined effect of evaporation and transpiration (usually referred to as evapotranspiration) is the second largest component of the water budget of watersheds and represents the combined effect of soils and vegetation on the amount of precipitation that becomes streamflow. It has been demonstrated in watershed studies that decreasing vegetation density can result in increased streamflow, and conversely it can also be shown that increased vegetation and canopy density tends to reduce streamflow in forested watersheds (Ziemer 1964, Bosch and Hewlett 1982, MacDonald and Stednick 2003). For the purpose of this analysis, it is assumed that vegetation conditions in the past were in between these two extremes and are approximated by the desired conditions of forest vegetation as represented by the departure index.

Impacts to forest soils can decrease that rate of infiltration and increase runoff, resulting in excess erosion, reduced productive capacity, and decreased water quality in streams. In this section, and in the watershed analysis, it is assumed that road density is correlated to the land use practices that most impact soils, but that a smaller percentage of roads that are hydrologically connected to streams is responsible for much of the effect (Nelson et al 2010, Al-Chokhachy et al. 2016).

Riparian areas in the western U.S. typically occupy 1 to 2 percent of total area but are disproportionally more important in their benefits to streams, aquatic habitats, and wildlife (Olson et al. 2007, Wissmar et al. 2004). Riparian vegetation responds to upslope changes in runoff and

sediment delivery to streams due to natural disturbances and land uses. The functions of riparian vegetation with respect to stream channels and aquatic habitats include benefits such as providing shade to moderate temperatures and microclimate, providing bank stability, contributing inputs of large wood and particulate organic material, and moderating sediment and nutrient input to streams (FEMAT 1993, Naiman et al. 1992). Riparian vegetation varies in extent, species composition, and age class structure in response to difference in elevation, temperature, growing season, length, hydrology, topography, and other factors. The functions of riparian vegetation may vary greatly between steep, narrow valleys in which stream are confined, and broad, flat valleys in which streams are able to migrate laterally across wide floodplains.

The condition of watersheds within the national forests of the Blue Mountains is represented by vegetation conditions, riparian conditions, and stream channel conditions. Differences in the effects of the alternatives are based on the rate of progress towards upland and riparian vegetation conditions, the degree of reduction in the hydrologic effects of forests roads, differences in livestock use, and the rate of implementation of stream and riparian restoration.

Ecological Resilience to Climate Change

Climate change is affecting average temperatures and precipitation in the Pacific Northwest. Average annual air temperatures across the region vary, but the observed rate of change has been relatively homogeneous. Average annual temperatures increased in the Blue Mountains by 1.4 degrees Fahrenheit in the 20th century, but about half of that increase occurred after 1970 (Mote 2003). Average precipitation across the Pacific Northwest increased by about 14 percent.

The rate of temperature change is expected to continue to increase in the 21st century with average temperature increases of 2.0 to 8.5 degrees Fahrenheit (1.1 to 4.7 degrees Celsius) by 2041-2070 relative to the 1970-1999 average of 43.9 degrees Fahrenheit (Mote et al. 2013). The Third Oregon Climate Assessment projects that average temperatures will increase by 3 to 7 degrees Fahrenheit (1.7 to 3.9 degrees Celsius) by the 2050s and 5 to 11 degrees Fahrenheit (2.8 to 6.1 degrees Celsius) by the 2080s relative to the 1970 to 1999 average. For comparison, temperatures in northeast Oregon (Climate Zone 8) have averaged 44.9 degrees Fahrenheit from 2000 through 2016 and only in one year since 2000 has annual temperature been lower than the 20th century average. Precipitation in the Pacific Northwest is expected to increase but projections of the magnitude of change are less certain than for temperature.

Temperature and precipitation changes have already resulted in observed changes in snow accumulation (Mote 2003, 2005; McCabe and Wolock 2009; Kapnick and Hall 2011). Warmer spring temperatures have been linked to earlier snowmelt timing (Cayan et al. 2001, Stewart et al. 2005) and earlier streamflow timing (Barnett et al. 2005). Warmer temperatures have already resulted in more precipitation falling as rain instead of snow (Knowles et al. 2006) and lower summer streamflow across the Pacific Northwest (Luce and Holden 2009). In snowmelt-dominated basins, there is an observed trend towards earlier spring runoff evidenced by an increase in the fraction of annual streamflow occurring during March, April, and May (Knowles et al. 2006, Stewart et al. 2005).

There are also indications that evapotranspiration rates are increasing and extending to earlier in the year (Hamlet et al. 2007) and this has implications for moisture availability and drought stress on vegetation later in the growing season (Bumbaco and Mote 2010), and wildfire occurrence (Littell et al. 2016, Marlier et al. 2017). Increased temperatures make increases in hydrologic extremes more likely. Future droughts may be more frequent and of longer duration (Adams et al.

2009, Dai 2011) and flood risk may increase locally as the frequency of winter rainfall increases and extends to higher elevations (Hamlet et al. 2007, Salathé et al. 2014, Guan et al. 2016).

Climate change is relatively gradual, and the magnitude of ecological responses in 10 to 20 years is anticipated to be relatively small compared to those anticipated in 50 to 100 years. However, while the average change may be gradual, it is often the more extreme circumstances and not the average degree of change that will likely be the reason for most of the effects (Halofsky and Peterson 2017). Over a few decades or more, climatic warming will likely increase and begin to dominate other natural climatic drivers. In a climate change context, resilience refers to the capacity of the natural environment to withstand or absorb increasing impact without changing states. Examples of natural resilience to climate change include conifer forests that regenerate to forest rather than to other vegetation types after repeated wildfire; animal species that retain viable populations despite climate-induced habitat degradation; and watersheds that retain erosion control, adequate water supply, and fish habitat despite floods, fires, insect epidemics, or spread of exotic plant species (Peterson et al. 2011).

When considering the potential impacts of climate change, improving ecological resilience becomes even more challenging. Ecological disturbances (such as fire, and insect and disease outbreaks), are all expected to increase in a warmer climate. These processes are extremely important factors affecting species distribution, stand age, and forest structure, facilitating transitions to new combinations of species and vegetation patterns. Mountain pine beetle has been and may continue to be particularly important in lodgepole pine and ponderosa pine forests, and western spruce budworm and Douglas-fir tussock moth may also increase periodically. Areas burned annually by wildfire are expected to increase substantially, and fire seasons will likely lengthen. In dry forest types where fire has not occurred for several decades, crown fires may result in high tree mortality. In addition, the interaction of multiple disturbances and stressors will create or exacerbate stress complexes. For example, an extended warm and dry period may increase bark beetle activity, which would increase short-term fine fuels (Halofsky and Peterson 2017).

Despite the uncertainty of impacts and effects associated with climate change, there are many proactive steps that land managers can take that are likely to increase ecosystem resilience to climate change. Many of the restoration and harvesting treatments described above that can confer benefits for non-climate reasons also have a recognized role as part of a climate change adaptation strategy (Peterson et al. 2011; Halofsky & Peterson 2017). For example, using the full suite of treatment options outlined above will facilitate the creation of a forest mosaic of different ages and structure across the Blue Mountains national forests. This serves as an adaptation strategy that will provide functional diversity and a range of habitats at large spatial and temporal scales. This will increase resilience to stressors and ensure that the effects of a warmer climate will not have uniform effects across this landscape. One or more age or structure combinations is likely to survive fires, windstorms, or other large disturbances.

All of the potential benefits of thinning and uneven-aged management treatment in terms of increasing vigor by reducing competition also increase the resilience of the forest to a warmer climate by reducing stand's susceptibility to disturbance and stressors. Uneven-aged stands typically provide a range of tree sizes as well as developing trees that are all available to quickly replace trees lost to disturbance. Resilience may be higher in multi-aged stands because of a smaller range of variation in structure over time that imparts a greater ability to quickly return to a pre-disturbance state (O'Hara 2006). Therefore, the multi-aged stands resulting from uneven-aged management are well positioned to tolerate chronic stress such as low soil moisture and

periodic disturbances caused by insects and fire, both of which will be more common in a warmer climate.

Post-fire tree planting can be used as a climate change adaptation tool to maintain native species, enhance species diversity and prevent forest lands from shifting to shrublands or grasslands. Under a changing climate, the survival of rare and increasingly vulnerable populations of whitebark pine may be enhanced by tree planting of genotypes resistant to white pine blister rust.

Similarly, actions proposed to reduce fire severity, restore watershed health or improve forest productivity can also facilitate adaptation to climate change. Incorporating openings in silvicultural prescriptions decreases forest density and fuel continuity, which may reduce wildfire severity and protect old trees (Churchill et al. 2013; Stine et al. 2014). Management practices that help fire to play a more natural role in ecosystems, such as thinning treatments, uneven-aged management, prescribed fire and wildland fire use, may also increase ecosystem resilience to wildfire under a changing climate (Peterson et al. 2011; Stine et al. 2014)

Key Indicators to Reflect Levels of Management Activities

Description of Vegetation Treatment Levels by Alternative

The following tables contain the estimated annual acres of harvesting, tree planting and precommercial thinning for the planning period under each alternative within the Malheur, Umatilla, and Wallowa-Whitman National Forests.

Table 115. Annual acres of harvesting, tree planting and precommercial thinning for each alternative for the Malheur National Forest

Activity	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod Dep.	Alt. F
Even-aged regeneration harvest	150	1,500	800	3,300	2,900	1,250	1,250	1,800
Uneven-aged management and commercial thinning	6,950	5,600	2,600	17,200	9,600	11,250	18,450	6,500
Total timber harvest	7,100	7,100	3,400	20,500	12,500	12,500	19,700	8,300
Planting	100	700	400	1,600	1,400	900	900	900
Precommercial thinning	1,400	1,400	1,000	3,000	1,400	1,600	1,600	1,400

Table 116. Annual acres of harvesting, tree planting and precommercial thinning for each alternative for the Umatilla National Forest

Activity	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod Dep.	Alt. F
Even-aged regeneration harvest	260	1,200	500	2,600	1,700	1,250	1,250	1,500
Uneven-aged management and commercial thinning	4,940	4,000	1,800	13,000	5,700	6,150	13,050	4,900
Total timber harvest	5,200	5,200	2,300	15,600	7,400	7,400	14,300	6,400
Planting	150	600	200	1,300	1,200	1,000	1,000	700
Precommercial thinning	1,600	1,600	1,500	3,200	1,600	1,400	1,400	1,600

Table 117. Annual acres of harvesting, tree planting and precommercial thinning for each alternative for the Wallowa-Whitman National Forest

Activity	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod Dep.	Alt. F
Even-aged regeneration harvest	90	1,000	500	2,500	2,000	1,500	1,500	1,400
Uneven-aged management and commercial thinning	4,410	3,550	1,550	13,750	7,350	7,800	15,000	4,650
Total timber harvest	4,500	4,550	2,050	16,250	9,350	9,300	16,500	6,050
Planting	50	500	200	1,200	1,000	1,200	1,200	700
Precommercial thinning	2,600	2,600	1,700	5,200	2,600	1,600	1,600	2,600

Under Alternative A (the existing plans), combined annual harvest levels for all three National Forests would be expected to continue at levels similar to, or modestly above those in the current programs. The majority of this harvesting would consist of commercial thinning. Alternative A would contain the lowest percentage of even-aged treatments, compared to the plan revision alternatives. Under Alternative A, even-aged management would total approximately 500 acres within all three National Forests. Precommercial thinning would total approximately 5,600 acres. Planting would total approximately 300 acres.

Under Alternative B, the total number of acres of timber harvest would be similar to Alternative A. In comparison to Alternative A, Alternative B would decrease the amount of commercial thinning somewhat while increasing the number of acres of even-aged regeneration management. This would result in a modest reduction in the conversion of dense stands into low density stands, but would increase the amount of young forest (stand initiation stage) on the landscape. Commercial thinning of dense stands would occur at levels of roughly one-half to two-thirds of Alternative E-Modified. The number of acres of planting would also increase from current levels, mostly as a response to increased even-aged management. The number of acres of precommercial thinning would remain the same as Alternative A.

Alternative C was designed to be the most restrictive alternative in terms of timber harvesting. This alternative considers an approach that would put more emphasis on passive forest restoration. Alternative C proposes the utilization of more wildfire managed for resource benefits to move vegetation towards the desired conditions. Alternative C would contain the greatest number of acres of preliminary administratively recommended wilderness areas, wider riparian management areas, designated old forest management areas and additional areas in wildlife corridor management areas. All of these additional management areas would reduce the number of acres suitable for timber production which would significantly limit the objective level of harvesting compared to the other plan revision alternatives. The amount of commercial thinning of dense forest stands would occur on only 15 to 30 percent of the amount projected under Alternative E-Modified. The amount of even-aged harvesting would be at the lowest level of the plan revision alternatives, as would the amount of associated tree planting. The level of precommercial thinning would remain similar to, or be decreased somewhat in comparison to all of the alternatives except Alternative D.

Alternative D is designed to put greater emphasis on timber production while also taking an aggressive active management approach to improve ecological resilience. In comparison to the other alternatives, Alternative D would contain the greatest number of acres suitable for timber production and would have the highest number of acres harvested annually within each national

forest. Under Alternative D, the total number of acres harvested annually would be approximately three times greater than Alternatives A or B, and this alternative would utilize the most even-aged regeneration harvesting to support both timber production and ecological structure class goals. Commercial thinning and uneven-aged harvesting would occur at approximately one and one-half to twice the rate projected under Alternative E-Modified. As part of the strategy to increase wood utilization to the extent possible, this alternative would rely more on removal of woody material instead of burning as a fuel reduction activity. Consequently, Alternative D would not implement prescribed burning outside of harvest units and would use only limited amounts of prescribed burning within harvest units. Additionally, Alternative D would implement the greatest amount of precommercial thinning and tree planting.

Under Alternative E, the total number of acres harvested annually would be approximately 1.5 to 2 times current levels. Overall harvesting levels would be similar to those of Alternative E-Modified, but would consist of more even-aged regeneration harvesting than Alternative E-Modified. The levels of projected tree planting would be elevated compared to current levels, and the acres of precommercial thinning would remain roughly the same as in Alternatives A and B.

Alternatives E-Modified and E-Modified Departure were designed to further increase the restoration effects beyond the levels of Alternative E. Alternative E-Modified would implement overall harvesting levels similar to Alternative E, but would improve the anticipated results in terms of resilience by focusing treatments on the overstocked dense portions of the dry upland forest that represent the greatest need for restoration and fuels reduction. However, Alternative E-Modified is still constrained by the “non-declining flow” rules which require that the amounts of timber planned for sale in any given decade cannot be less than previous decades. As a consequence only a moderate increase in additional commercial thinning compared to Alternative E (about 5 to 15 percent more) could be scheduled under Alternative E-Modified.

Alternative E-Modified Departure, however, was designed under an exception to the standard planning rules which allow for a “departure” from the non-declining flow requirements. Under this scenario, this alternative was designed to thin, within approximately 20 years and the life of a plan period, virtually all of the dense dry forest that currently exists within the lands that are suitable for timber production as well almost three-quarters of the total dense dry upland forest on other lands that allow harvesting to occur as a restoration tool. This strategy would result in the highest levels of expected commercial thinning and uneven-aged harvesting over the next planning horizon. In subsequent decades, after most of the thinning backlog has been addressed, the amount of thinning in dense forests would decline markedly, as would the resulting timber volumes.

Under Alternative F, the annual harvesting schedule would be modestly elevated (approximately 20 to 30 percent), compared to Alternatives A and B, but significantly less than Alternative E-Modified. The total number of acres of planting would increase, in comparison to Alternative A. The number of acres of precommercial thinning would remain the same as Alternatives A and B.

Annual Forest Vegetation Active Restoration Activities

The acres displayed in Table 118 would be the sum of the annual harvest treatments, tree planting, and precommercial thinning. To restore ecological resiliency, these treatments would be designed to make progress toward achieving multiple desired conditions, such as forest structural stages, species composition, stand density, and fire regime condition class.

Table 118. Annual acres of forested vegetation harvest treatments, tree planting, and precommercial thinning (with the percent change from existing levels in parentheses) under each alternative within each National Forest

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod(dep)	Alt. F
Malheur	8,600 (0%)	9,200 (+7%)	4,800 (-44%)	25,100 (+192%)	15,300 (+78%)	15,000 (+74%)	22,200 (+158%)	10,600 (+23%)
Umatilla	6,950 (0%)	7,400 (+6%)	4,000 (-42%)	20,100 (+189%)	10,200 (47%)	9,800 (+41%)	16,700 (+140%)	8,700 (+25%)
Wallowa-Whitman	7,150 (0%)	7,650 (+7%)	3,950 (-45%)	22,650 (+217%)	12,950 (+81%)	12,100 (+69%)	19,300 (+170%)	9,350 (+31%)

Under Alternative A, harvest treatments, planting, and precommercial thinning would continue to occur at levels similar to the current rates. Within all three National Forests, Alternative D would implement the greatest number of combined acres of harvest treatments, tree planting, and precommercial thinning. The management regime under Alternative D, would accelerate treatments from current levels by approximately 190 percent to 220 percent within the planning period. Within all three National Forests, Alternative E-Modified Departure would result in the second greatest number of acres of harvest treatments, planting, and precommercial thinning. Under Alternative E-Modified Departure, treatments would accelerate from current levels by approximately 140 percent to 170 percent within the analysis area. Alternative C would result in the lowest number of acres of harvest treatments, planting, and precommercial thinning. Under Alternative C, treatments would decline by approximately 40 percent to 45 percent within the planning period.

Table 119 displays the estimated annual acres of prescribed burning treatments estimated to occur both inside and outside of harvest units.

Under all of the alternatives, except Alternative D, prescribed burning outside of harvest units would continue at the current rate of approximately 30,000 acres per year across all three National Forests. Under Alternative D, the use of prescribed fire outside of harvest units would be eliminated.

Under Alternative D, most of the activity-generated fuels inside of activity units would be treated mechanically. The majority of the fuels treatments within harvest units would be accomplished by removal or crushing instead of prescribed burning. Only approximately one quarter of the total acres harvested annually would be treated with prescribed burning. Using mechanical treatments as a substitute for fire would present tradeoffs in terms of ecological processes and treatment costs.

Because Alternative E-Modified Departure has a high level of scheduled harvesting, and it would plan to fully utilize prescribed burning as a tool, it would result in the greatest number of acres of prescribed burning inside of harvest units within all three National Forests. Conversely, Alternative C would result in the fewest number of acres of prescribed burning inside of harvest units within all three National Forests.

Table 119. Annual acres of prescribed burning treatments under each alternative within each National Forest

National Forest	Activity	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur	Prescribed burning outside of harvest units	9,500	9,500	9,500	0	9,500	9,500	9,500	9,500
Malheur	Prescribed burning inside of harvest units	5,300	5,300	2,500	5,100	9,400	9,400	14,800	6,200
Malheur	Treatment or removal of fuels with ground-based equipment inside of harvest units	1,800	1,800	900	15,400	3,100	3,100	4,900	2,100
Umatilla	Prescribed burning outside of harvest units	10,000	10,000	10,000	0	10,000	10,000	10,000	10,000
Umatilla	Prescribed burning inside of harvest units	3,900	3,900	1,700	4,000	5,550	5,550	10,700	4,800
Umatilla	Treatment or removal of fuels with ground-based equipment inside of harvest units	1,300	1,300	600	12,000	1,850	1,850	3,600	1,600
Wallowa-Whitman	Prescribed burning outside of harvest units	10,500	10,500	10,500	0	10,500	10,500	10,500	10,500
Wallowa-Whitman	Prescribed burning inside of harvest units	3,400	3,450	1,550	4,300	7,050	6,975	12,375	4,550
Wallowa-Whitman	Treatment or removal of fuels with ground-based equipment inside of harvest units	1,100	1,100	500	12,700	2,300	2,325	4,125	1,500

Table 120 displays the estimated annual acres of active forest restoration treatments. These treatments include all harvesting, tree planting, precommercial thinning and all prescribed burning conducted outside of harvest units. The table also portrays the sum of all these active restoration treatments as a percentage of the total forest land acres located outside of wilderness allocations. Acres of prescribed burning within harvest units were not included to avoid double-counting the effect of those acres already treated with harvesting.

Table 120. Estimated annual acres of active forest restoration activities* located outside wilderness areas treated annually under each alternative by National Forest

National Forest	Restoration Activities	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur	Annual acres of forest vegetation active restoration activities*	18,100	18,700	14,300	25,100	24,800	26,800	34,000	20,100
Umatilla	Annual acres of forest vegetation active restoration activities*	16,950	17,400	14,000	20,100	20,200	19,800	26,700	18,700
Wallowa-Whitman	Annual acres of forest vegetation active restoration activities*	17,650	18,150	14,450	22,650	23,450	22,600	29,800	19,850

* Estimated annual acres of active forest restoration treatments include all harvest treatments, tree planting, precommercial thinning, and prescribed burning conducted outside of harvest units.

All of the plan revision alternatives work toward similar desired conditions for forest vegetation related to ecological resilience (forest structural stages, species composition, stand density, fire regime condition class, and so forth). The rate and scale at which active management attempts to move toward the range of desired conditions is important because the pace of restoration activities has not kept up with the negative impacts resulting from continual forest ingrowth, fuel accumulation and a changing climate.

Alternative E-Modified Departure represents the most rapid pace of implementation in regards to active restoration treatments over the planning period, with accelerated levels of harvesting along with associated prescribed burning treatments. However, in subsequent decades, the amount of restoration work would decline markedly as the timber harvest schedule returns to a level that can produce non-declining volume flows over the long-term. Alternatives D, E, and E-Modified would each implement a pace of restoration that is similar to one another in terms of overall treatment level, and these three alternatives would all represent substantial increases over current treatment rates. Among them, the pace represented by Alternative E-Modified would be superior in terms of ecological resilience, in that it would specifically focus more restoration treatments on the areas of the forest that are most at risk because they are highly departed from the desired ecological conditions, namely the overly dense portions of the dry upland forest. Given the current scarcity of desired resilient old forest structural stages within the dry upland forest, having time to mature further is a key component of the overall restoration solution. The accelerated rates of management associated with these two alternatives, when combined with their focus on the most critical ecological needs of the dry upland forests, should reduce the current risk levels of the forests, which will allow for continued beneficial development to occur over time. The paces of either Alternatives E-Modified or E-Modified Departure would support the best attainment in terms of improving ecological resilience over the near and mid-terms.

The slowest rate of active treatments within the Blue Mountains national forests would be planned under Alternative C. Timber harvesting would be deemphasized under this alternative. Other treatments like planned prescribed fire and managed wildfire would be relied on to accomplish necessary restoration work. However, the more detailed results presented in the Forest Vegetation section of this chapter indicate Alternative C’s slower paced strategy will be associated with the weakest results among the alternatives in terms of moving the forest toward conditions similar to the historical range of variation.

Road Treatments in Priority Watersheds

The emphasis of road-related treatment objectives, as stated in Appendix A, is to reduce road-related sedimentation by reducing hydrological connectivity between roads and streams on National Forest System lands. Hydrologically connected roads are defined as roads or portions of roads that route water and sediment directly to stream channels. The extent of hydrologically connected roads was estimated using Geographic Information System and approximated by the miles of roads occurring within 300 feet of streams for the purposes of this analysis. The method may overestimate the actual miles of hydrologically connected roads, but comparison of treatment objectives by alternative as a percentage of the miles of hydrologically connected roads in priority watersheds allows a relative comparison of the potential reduction in road-stream connectivity what would occur in each alternative. Available literature suggests that the two primary modes of road-stream connectivity are stream crossings and leadoff culverts from road drainage ditches that either drain directly to streams or have gullies below their outlets. Potential remedies include improving or dissipating road drainage, reducing the spacing between road drainage features, outsloping of road surfaces, adding gravel to unsurfaced roads, and any other

measure that reduces or dissipates the energy of road related runoff. Several studies, including one conducted on the Umatilla National Forest, have noted that a high percentage of road-related sediment delivery to streams is produced by a small percentage of the road network. On the Umatilla National Forest, Nelson et al. (2010) found that 90 percent of road-related sediment delivered to streams was produced by 12 percent of the road network.

The degree of road-stream connectivity is a function of both road density and the layout of national forest roads relative to the channel network. Road-stream connectivity is addressed by evaluating the degree to which hydrologically connected roads act as extensions of the channel network. Part of the rationale for this is that roads intercept subsurface flow and route intercepted flow to streams via road drainage features. Because surface flow (measured in feet per second) is more rapid than subsurface flow (measured in feet per hour or feet per day), the result is that a higher volume of storm runoff reaches streams more quickly and contributes to increased peak flows.

The objective miles for reducing road-stream connectivity are expected to be completed first in priority watersheds, and secondarily in other key watersheds (for example, if the objective exceeds estimates of miles of hydrologically connected roads, then work would be completed in other watersheds). The analysis assumes that road-stream connectivity can be reduced but not eliminated.

The objective miles for treating hydrologically connected roads and the percentage of hydrologically connected roads in priority watersheds that this represents, are displayed by alternative for each forest in Table 121. Road treatment objectives are not displayed for Alternative A because comparable objectives are not included in the existing forest plans.

Table 121. Miles of road treatments, and percentage of hydrologically connected roads in priority watersheds expected to be treated in 10 years for each alternative for each national forest

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur	NA	260 23%	600 53%	650 58%	290 26%	300 27%	500 44%	310 27%
Umatilla	NA	260 83%	400 128%	800 257%	300 96%	350 112%	600 193%	270 87%
Wallowa-Whitman	NA	260 38%	400 59%	800 118%	300 44%	350 52%	600 89%	270 40%

Objectives for each alternative were developed based on budget assumptions and not necessarily on the magnitude of the need of each national forest. Similar treatment objectives result in relatively lower benefit on the Malheur National Forest and higher benefit on the Umatilla National Forest due mainly to differences in the extent of the road system on each national forest.

On the Umatilla National Forest, the objective for road treatment is higher than the estimate of existing hydrologically connected road miles in Alternatives C, D, E-Modified and E-Modified Departure, but is still high in the remaining alternatives. This suggest that the hydrologic effects of roads in priority watersheds can be substantially reduced in all alternatives. In Alternatives D and E-Modified Departure, this benefit would extend to most (Alternative E-Modified Departure) or all (in Alternative D) key watersheds. Treatment of hydrologically connected roads would likely occur in Alternative A at a rate similar to, but lower than in Alternative B.

The initial estimate of hydrologically connected road miles includes closed roads because the condition of these roads could not be readily determined. Closed roads comprise about 40 percent of the estimate of hydrologically connected roads on the Malheur and Umatilla National Forests, and 50 percent of the estimate of hydrologically connected roads on the Wallowa-Whitman National Forest. Site-specific analysis will likely find that some of these roads are not hydrologically connected or sources of sediment delivery to streams. However, some roads that are currently located adjacent to streams are likely to be at increased risk from flood damage as the hydrologic regime changes in response to climate warming (Clifton et al. 2017, Chapter 4).

Forage Use in Priority Watersheds

Livestock grazing is among the most widespread land uses in the interior Pacific Northwest and has occurred in the Blue Mountains for nearly 150 years. Livestock grazing affects vegetation, soils, water quality and, to a much lesser extent, water quantity. Grazing effects are potentially higher in riparian areas because they are used preferentially by livestock (Bryant 1982, Platts 1991). Changes in grazing practices, such as allowing for periods of rest from grazing, implementation of rest-rotation grazing schemes, adjustment of livestock numbers, and adherence to forage utilization guidelines have been used to improve range and riparian vegetative conditions.

This factor is included as a measure of ecological resilience because of the importance of riparian areas to ecological functioning of streams and watersheds (Gregory et al. 1991, Naiman et al. 1992), and because riparian areas integrate the interactions between aquatic and terrestrial components of watersheds (Naiman 2005, p.2). Livestock grazing presently occurs on 42 percent of the national forests in the Blue Mountains, excluding the Hells Canyon National Recreation Area and would occur on 18 percent (Alternative C) to 47 percent (Alternatives E-Modified and E-Modified Departure) of the national forests, depending on the alternative selected. Livestock are known to use riparian areas preferentially (Kauffman and Krueger 1984) unless limits are placed on the use of riparian vegetation (Clary and Leininger 2000), or where riparian areas have been fenced to exclude livestock or to manage livestock use more conservatively. While it is possible to predict forage use at a broad scale, it is not necessarily possible to predict the average use of riparian areas by livestock with confidence. Additional detail is provided in the “Watershed Function, Water Quality, and Water Uses” section of this document. Table 123 (page 270) displays the estimate of average forage use by livestock as a percentage of average forage production. Averages for all watersheds and priority watersheds are displayed separately for each forest.

In some streams, the presence of deep-rooted herbaceous species (*Carex* spp. *Juncus* spp., *Deschampsia* spp., *Salix* spp.) and willows (*Salix* spp.) is the main factor that controls bank stability and channel shape. Reduction or loss of riparian species or root mass can result in reduced bank stability and increases in bank erosion. Other factors, including channel degradation (gully formation), floods, channelization, removal of beaver, removal of large wood, and livestock grazing may directly or indirectly result in reduction, conversion, or loss of riparian habitats, with subsequent effects on water quality, stream productivity, and aquatic habitats.

Channel degradation, conversion, or loss of these species can occur in response to floods, channelization, removal of large wood, gully formation, and other factors described in the “Watershed Function, Water Quality, and Water Uses” section of this document, in addition to livestock grazing.

Prior to the establishment of forest reserves, and primarily before about 1900, livestock grazing was unregulated and resulted in degraded range conditions. Skovlin (1991) estimated that livestock numbers were reduced by half between 1900 and 1910 following the establishment of the Blue Mountains Forest Reserve. Further reductions occurred between 1910 and 1990. On National Forest System lands in the Upper Grande Ronde River, for example, livestock numbers were reduced from 211,000 animal unit months in 1911 to 51,000 animal unit months in 1990, compared to 18,250 animal unit months in the same area as of 2013, which represents a 96 percent reduction of livestock numbers after 1900.

In the watershed analysis, livestock use intensity is used to compare the relative intensity of grazing between alternatives. The method follows Holechek et al. (2006) who proposed that adverse effects of grazing on forage species can be avoided if forage use intensity, expressed as a percentage of long-term average forage production, does not exceed 40 percent. The method allows the identification of areas or watersheds in which apparent forage use is relatively high or low.

Table 122 displays the expected level of permitted livestock (cattle and sheep) use expected to occur in each alternative. The numbers for Alternative A reflect use levels under the existing forest plans. The alternatives differ in the acres that are suitable for livestock use. Livestock animal unit months on the Malheur National Forest are lower in Alternative A than in Alternatives B, E, and F. Total livestock animal unit months in Alternative A are slightly higher than in Alternatives B, E, and F on the Umatilla and Wallowa-Whitman National Forests. Livestock numbers are lowest in Alternative C because it has the lowest number of acres suitable for grazing. Livestock numbers are highest in Alternatives E-Modified and E-Modified Departure because they would potentially allow grazing on currently vacant allotments. The main difference in grazing use between Alternative C and the modified alternatives is that Alternative C would have the fewest watersheds in which grazing would be allowed and the modified alternatives would have the most watersheds in which grazing would be allowed. The modified alternatives would also include a guideline (GM-3G) that requires adjustment of grazing practices depending on whether desired range and riparian conditions are being met (see Volume 4, Appendix A, “MA4B Riparian Management Areas,” “Range Management and Domestic Livestock Grazing within MA 4B”).

Table 122. Animal unit months (AUMs) by alternative for the Malheur, Umatilla, and Wallowa-Whitman National Forests

SUM of AUMs (Cattle + Sheep)	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur	123,500	126,500	62,200	125,500	123,500	133,200	133,200	123,500
Umatilla	37,800	35,600	4,200	35,800	35,800	49,200	49,200	35,800
Wallowa-Whitman	81,500	77,500	29,500	84,500	80,500	112,000	112,000	80,500
Total AUMs by Alternative	242,800	239,600	95,900	245,800	239,800	294,400	294,400	239,800

Relative to Alternative A, average forage use by livestock is higher across all watersheds in all plan revision alternatives except C on the Malheur National Forest. On the Umatilla National Forest, average forage use is higher than in Alternative A in the modified alternatives and lower than Alternative A in Alternatives B, C, D, E, and F. On the Wallowa-Whitman National Forest,

average forage use is higher than Alternative A in Alternatives B, D, E-Modified, and E-Modified Departure, and lower than Alternative A in Alternatives C, E, and F.

The estimate of forage use intensity averaged separately for all watersheds and for priority watersheds is displayed in Table 123. Forage use intensity is lowest in Alternative C on each National Forest compared to all alternatives as it would have the fewest acres suitable for grazing. The modified alternatives would have the highest overall forage use on each National Forest, but the increase would be due to the inclusion of suitable acres on vacant allotments and in more watersheds, not by a change in use intensity where grazing is currently authorized. Forage use on the majority of priority watersheds is predicted to be between 10 percent and 40 percent on all three National Forests, except in Alternative C, in which forage use would be substantially lower. On the Malheur National Forest, forage use intensity would be less than 10 percent in 23 of 34 priority watersheds in Alternative C. On the Umatilla National Forest, the average forage use intensity in 15 priority watersheds would be less than 1 percent. On the Wallowa-Whitman National Forest, forage use intensity in priority watersheds would average 1.6 percent and would be less than 10 percent in 25 of 26 priority watersheds.

Table 123. Average percent of forage use intensity in priority watersheds for each alternative for each National Forest

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur Avg. all WS	23.5%	26.5%	14.2%	26.3%	26.0%	26.5%	26.5%	26.0%
Malheur Avg. PWS	16.6%	20.9%	7.1%	20.7%	19.6%	22.9%	22.9%	19.6%
Umatilla Avg. all WS	10.6%	10.0%	1.4%	10.1%	10.1%	13.7%	13.7%	10.1%
Umatilla Avg. PWS	10.1%	10.1%	0.6%	10.1%	10.1%	13.8%	13.8%	10.1%
Wallowa-Whitman Avg. all WS	20.6%	19.9%	9.2%	21.3%	20.4%	25.2%	25.2%	20.4%
Wallowa-Whitman Avg. PWS	15.1%	15.5%	1.6%	17.5%	14.9%	23.7%	23.7%	14.9%

WS = watersheds, PWS = priority watersheds

Forage use on the Malheur National Forest would be slightly lower in Alternative A than in Alternative B based on differences in animal unit months. Average forage use in watersheds on the Umatilla National Forest would be slightly higher in Alternative A than in Alternative B, but forage use in priority watersheds would be nearly the same in Alternatives A and B. Average forage use in watersheds on the Wallowa-Whitman National Forest would be higher in Alternative A than in Alternative B, while forage use in priority watersheds would be lower in Alternative A than in Alternative B.

For the Malheur National Forest, in Alternatives E-modified and E-modified departure estimated forage use intensity is less than 10 percent in only one priority watershed, compared to eight priority watersheds in Alternative A, and potentially higher than 40 percent in 2 priority watersheds, compared to none in Alternative A. On the Umatilla National Forest, forage use intensity would be less than 10 percent in 6 of 15 priority watersheds, the same as in Alternative

A, but average forage use in priority watersheds would be about 14 percent, the lowest level among the three forests. On the Wallowa-Whitman National Forest, forage use intensity in the modified alternatives would average nearly 24 percent but would be less than 10 percent in 6 of 26 priority watersheds, compared to 11 in Alternative A. Under the modified alternatives, GM-3G would provide a mechanism fort adjusting grazing practices in cases where desired riparian conditions are not being met and could result in lower utilization standards and lower forage use in some watersheds than is displayed here.

The watershed analysis is constructed to show the relative differences between alternatives. In the case of livestock use it shows that higher livestock use has a greater effect on watershed conditions. That difference is greatest when comparing Alternative C to Alternatives E-Modified and E-Modified Departure and is not solely based on differences in the intensity of livestock use between alternatives, but also displays differences based on the spatial distribution of livestock use because it is based on the number of permitted livestock in individual watersheds.

Riparian and Stream Channel Restoration

Riparian areas are found in areas bordering streams, rivers, lakes, and wetlands (NRC 2002, Chapter 2). The extent of riparian vegetation is influenced by local topography, channel and floodplain morphology, hydrologic characteristics (including groundwater and surface flow regimes and water requirements) and inundation tolerances of riparian plant species. Because land use effects and natural disturbance in watersheds affect the routing of water and sediment within watersheds, and both of these factors affect channel morphology, riparian areas reflect the condition and frequency of upstream disturbance.

FEMAT (1993) and Naiman et al. (1992) described the functions of riparian areas and their relationship to stream channel integrity in forested watersheds. These functions include the provision of shade, microclimate, bank stability, nutrients, and delivery of organic material in the form of large wood, but also particulate organic material that forms the basis of aquatic food webs (Bilby and Bisson 1992, Allan 1995, Thomas et al. 2005). The routing of water, sediment, and organic material are the key processes that regulate ecological health of watersheds in the Pacific Northwest (Naiman et al. 1992). Riparian areas regulate the interaction of streams and their watersheds. Because most of the material transfers between watersheds and streams occur during or following disturbance, protecting the interactions between streams and surrounding terrain is fundamentally important to the health of river systems (Bisson et al. 1997).

Riparian areas within the national forests in the Blue Mountains may be forested or nonforested. Nonforested riparian areas are more likely to occur along streams that occupy wide, low-gradient valleys in which riparian vegetation is dominated by a combination of riparian shrubs and herbaceous species, or that may consist solely of herbaceous species. Forested riparian areas in the Blue Mountains may consist of riparian tree species such as black cottonwood, or aspen, or may consist of one of three forest potential vegetation groups described in this section: dry forest, moist forest, and cold forest.

The majority of riparian systems in the Pacific Northwest have been greatly altered by past land use (Wissmar 2004). Within the national forests of the Blue Mountains, the largest changes to riparian areas have occurred in the last 150 years following white settlement of the Pacific Northwest, and have included placer mining, river channelization, development and conversion of floodplain vegetation to livestock pastures and irrigated agriculture, uncontrolled livestock grazing that occurred largely before the national forests were established, water diversions, riparian logging, log drives, railroads, roads, and the depletion of large wood in streams.

In many cases, riparian degradation has occurred as a result of channel degradation, or in response to channel degradation. Channel degradation, or channel incision, is evidenced by erosion of the channel bottom to a lower elevation. Aggradation raises channel bed elevations, usually by excess sediment deposition. Within the national forests in the Blue Mountains, nearly 300 sites have been established to monitor stream channel and riparian conditions as part of the PACFISH-INFISH Biological Opinion effectiveness monitoring program. Review of the monitoring data, including photographs of each site, suggests that 128 of 294 sites (44 percent) are incised streams. This includes 88 of 164 (54 percent) monitoring reaches on the Malheur National Forest, 8 of 46 sites (17 percent) on the Umatilla National Forest, and 32 of 84 (38 percent) sites on the Wallowa-Whitman National Forest. The actual number of incised stream is likely higher as not all incised reaches can be identified with the information available for this analysis. Channel erosion can occur, for example by loss or removal of large wood from streams, the removal of beaver, channelization, channel constriction by roads and railroads, floodplain alteration, log drives, and splash dams. On at least some streams, channel erosion has occurred because mainstem rivers have eroded and the resulting change in base level has forced tributary streams to adjust to a lower base elevation. Some channel erosion may be recent, but it appears that channel erosion in several river basins has been ongoing for multiple decades and may be more than a century old. The effect of channel degradation on riparian vegetation is that, in some streams, the adjacent floodplain vegetation has been converted from riparian species (willows, sedges, rushes) to upland species (sage brush, for example), or the extent of riparian vegetation has been greatly reduced. In some cases, the original channel degradation occurred long enough in the past that new, vegetated floodplains have developed at lower elevations and affected streams have recovered to near their pre-disturbance condition and riparian extent. Additional information can be found in the “Watershed Function, Water Quality, and Water Uses” section of this document.

Two indicators of riparian conditions are presented here as a basis for comparison of the alternatives:

- The average vegetation departure index for forested riparian areas, displayed as an average for all watersheds and for priority watersheds (at 10 years and 20 years)
- The percentage of riparian habitats that would be improved or restored under each alternative.

The vegetation departure index for riparian areas is calculated separately for individual watersheds and is used in the watershed analysis presented in this document.

The objectives displayed for stream channel and riparian improvements in Appendix A are compiled in the watershed analysis (Table 205 and Table 206) to show the potential miles of stream and riparian restoration and acres of riparian restoration. The results, displayed in miles of stream improved and the percentage of stream miles improved in priority watersheds, along with the acres of riparian habitats (and percent of acres) improved or restored, are displayed in Table 124. The miles of stream and acres of riparian habitats to be restored are also displayed as a percentage of the estimate of stream miles and riparian acres that exist in priority watersheds on each national forest.

Watershed-related objectives are expected to be completed in priority watersheds within 10 years of plan implementation. Reprioritization of watersheds for restoration will occur periodically and watershed restoration work is expected to occur continuously into the future, or as long as there is a need.

It is recognized that objectives may overlap and that multiple objectives may apply to a single stream reach or watershed. Further, miles and acres are calculated based on the total number of stream miles in priority watersheds and may overestimate the locations where stream and riparian restoration may occur. Table 124 through Table 126 display in parentheses the total number of stream miles and total estimated acres of riparian habitats in priority watersheds on each National Forest. The methods for the calculation are in the text and footnotes which accompany Table 205, and Table 206 in the "Watershed Function, Water Quality, and Water Uses" section of this document.

Table 124. Miles of improved stream and riparian areas for each alternative for the Malheur National Forest

Indicator Measured	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Sum of stream miles (550)	NA	71	110	64	90	128	120	80
Percent of stream miles improved	NA	13%	20%	12%	16%	23%	22%	14%
Sum of riparian & wetland acres improved (1,680)	NA	427	941	928	639	639	589	606
Percent of habitat acres improved	NA	25%	56%	55%	38%	38%	35%	36%

Table 125. Miles of improved stream and riparian areas for each alternative for the Umatilla National Forest

Indicator Measured	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Sum of stream miles (550)	NA	86	152	82	117	117	112.5	109
Percent of stream miles improved	NA	35%	62%	33%	48%	48%	46%	44%
Sum of riparian & wetland acres improved (1,680)	NA	368	831	619	551	550	524	523
Percent of habitat acres improved	NA	49%	112%	83%	74%	74%	70%	70%

Table 126. Miles of improved stream and riparian areas for each alternative for the Wallowa-Whitman National Forest

Indicator Measured	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Sum of stream miles (550)	NA	121	201	104	151	150.8	136	135
Percent of stream miles improved	NA	28.4%	47.4%	24.5%	35.6%	35.6%	32.1%	31.8%
Sum of riparian & wetland acres improved (1,680)	NA	473	1,039	824	708	707.5	632	631
Percent of habitat acres improved	NA	36.8%	80.8%	64.1%	55.1%	55.1%	49.2%	49.1%

The existing departure index for forest vegetation in riparian management areas and the departure index resulting from each alternative for year 10 and year 20 are displayed by national forest in the “Watershed Function, Water Quality, and Water Uses” section. The values displayed are average indexes over all watersheds and for priority watersheds.

On the Malheur National Forest, the lowest vegetation departure and greatest improvement from existing conditions occurs in Alternative E-Modified at both year 10 and year 20 (Table 173 and Table 174). This is consistent with the greater level of improvement and higher degree of vegetation management in dry forests, which are more extensive on the Malheur National Forest. Alternative C results in less improvement than any other alternative.

On the Umatilla National Forest, the lowest vegetation index values at year 10 occur in Alternatives C and D, then in Alternatives E-Modified and E-Modified Departure (Table 195 and Table 196. By year 20 the lowest vegetation index values would occur in Alternatives E-Modified and E-Modified Departure, reflecting an increase in the rate of change that would occur in the modified alternatives.

On the Wallowa-Whitman National Forest, the lowest average departure index values at year 10 for all watersheds and priority watersheds occurs in the modified alternatives, then in Alternatives F, B, and C (Table 217 and Table 218). The lowest departure index values also occur in the modified alternatives at year 20.

Key Indicators to Reflect Resilient Conditions

Improvement in the Dry Upland Forest Potential Vegetation Group Departure Index

This section quantifies the degree to which the dry upland forest potential vegetation group’s structure, size class and stand density have departed from desired conditions using the measure of vegetation departure index. The computation of the vegetation departure index values is based on the succession class vegetation departure calculations outlined in the Interagency Fire Regime Condition Class Guidebook (Barrett et al. 2010). Vegetation output data from the Vegetation Development Dynamics Tool model (ESSA Technologies Ltd. 2007) runs for each of the three upland forest potential vegetation groups was classified into one of the five fire regime condition class vegetation-succession classes (see the “Forest Vegetation” section of Chapter 3 for more information on the Vegetation Development Dynamics Tool modeling). The crosswalk for each potential vegetation group was based on a combination of structure, diameter (at breast height) and canopy cover.

The acres existing in each succession class for each potential vegetation group were then expressed as a percentage of the total potential vegetation group. Reference values for each fire regime condition class succession class were developed based on the midpoints of the forest vegetation historical ranges of variability. Current and projected forest vegetation succession class percentages were compared to the reference values to determine the percentage of similarity between the current and reference amounts. The sum of these values for all five fire regime condition class succession classes is the similarity index. The vegetation “departure” index is simply the inverse of the similarity index (100 – similarity index).

Table 127. Crosswalk between structural stages and fire regime condition class succession classes

Structural Stages and Density	Potential Vegetation Groups	Size Class	Fire Regime Condition Class Succession Class
Stand initiation stages – open & closed canopy	Dry, moist & cold upland forests	Less than 5 inches diameter.	A – Early seral
Stem exclusion & understory reinitiation stages – closed canopy	Dry, moist & cold upland forests	5 to 20 inches diameter.	B – Mid-seral closed
Stem exclusion & understory reinitiation stages – open canopy	Dry, moist & cold upland forests	5 to 20 inches diameter.	C – Mid-seral open
Old forest single story & old forest multi-story – open canopy	Dry, moist & cold upland forests	Larger than 20 inches diameter.	D – Late-seral open
Old forest single story & old forest multi-story – closed canopy	Dry, moist & cold upland forests	Larger than 20 inches diameter.	E – Late-seral closed

Departure index measures the degree to which the forest composition, structure and density vary between current and reference conditions and it is being used as an inference of resilience and sustainability; the lower the departure index, the less departed, or closer the vegetation is to reference conditions and the greater the resilience. The results presented here compare what the predicted degree of relative departure and trend would be after fully implementing the vegetation treatment objectives of each alternative. Departure index classes include the following:

- **Low departure (departure index less than 33 percent):** Size class, density, and structure of forest vegetation is similar to the historical range of variation and levels of natural resilience to disturbance are generally high. Risk of losing key ecosystem components (e.g., native species, forest structure, soil) is minimal to low.
- **Moderate departure (departure index greater than 33 percent but less than 66 percent):** Size class, density, and structure of forest vegetation is significantly altered from the historical range of variation and the risk of losing key ecosystem components ranges from moderate to high. Areas within this departure index class will likely need moderate levels of restoration treatments (fire or mechanical) to be restored to resilient conditions.
- **High departure (departure index greater than 66 percent):** Size class, density, and structure of forest vegetation is highly altered from the historical range of variation and the risk of losing key ecosystem components ranges from high to very high. Areas within this DI class will likely need significant levels of restoration treatments (fire or mechanical) to be restored to resilient conditions.

Table 128 displays the changes in departure index values for the dry upland potential vegetation group under each of the alternatives projected over 50 years by national forest. A more thorough discussion of all upland forest potential vegetation groups can be found in the “Forest Vegetation,” “Timber and Forest Products,” and “Wildland Fire” section of this document. The changes in the vegetation departure index values reflect the combined effects of the treatments discussed above as well as growth and succession processes along with natural disturbances. Those alternatives that are projected to make the most progress towards reducing elevated departure index values for the dry upland forest potential vegetation group were assumed to be moving toward more ecologically resilient conditions over time.

Table 128. Vegetation departure index values within the dry upland forest potential vegetation group for each alternative by National Forest

National Forest	Year	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur	Existing condition	62	62	62	62	62	62	62	62
Malheur	Year 20	56	54	56	47	51	51	49	53
Malheur	Year 50	48	46	50	34	38	37	36	43
Umatilla	Existing condition	60	60	60	60	60	60	60	60
Umatilla	Year 20	57	55	57	49	53	52	51	54
Umatilla	Year 50	48	47	52	40	41	40	40	44
Wallowa-Whitman	Existing condition	57	57	57	57	57	57	57	57
Wallowa-Whitman	Year 20	58	56	57	50	52	52	51	54
Wallowa-Whitman	Year 50	54	52	55	45	45	45	45	50

Within the dry upland forest potential vegetation group, none of the alternatives would be likely to result in attainment of a low degree of vegetation departure within either the 20-year or 50-year timeframe. However, all of the alternatives are expected to support some degree of improvement trend toward the low class of vegetation departure. The approaches represented by the alternatives will all probably require more than 50 years to result in a return to a low class of departure because of the additional time needed for the old forest structures within the dry upland forest to develop. Alternative D makes the most rapid progress, though all of the alternatives with generally more robust active restoration programs perform better than the more passive approaches. Alternatives D, E, E-Modified and E-Modified Departure all are projected to come the closest to the “low” threshold after 50 years.

Alternatives A and C are predicted to make the least amount of progress toward improving the condition and corresponding resilience of the dry upland forest. These alternatives would result in little improvement within 20 years, with the departure index values remaining at the high end of moderately departed. After 50 years these alternatives would likely still only make marginal progress toward improving the dry upland forest. The weaker performance of these two alternatives may be related to their more restrictive approaches in regards to where treatments could occur and what array of techniques could be used as restoration treatments. For example, Alternative C contains the greatest number of acres of preliminary administratively recommended wilderness areas, wider riparian management areas, designated old forest management areas and additional areas in wildlife corridor management areas. It also would be the most conservative alternative in terms of using timber harvesting. All of these factors would reduce the amount of currently uncharacteristically dense dry upland forest that could be immediately treated. Similarly, Alternative A would plan for a continuation of the current levels of restoration treatment work along with a carryover of the old forest restrictions of the Eastside Screens plan components. These factors would also limit the ability of Alternative A to implement a full suite of restoration treatments within all of the areas where the need is currently greatest.

A consistent pattern across all three National Forests shows that Alternatives D, E, E-Modified, and E-Modified Departure, all of which entail higher levels of harvesting, and other restoration related activities, tend to improve the departure index values the most. By allocating more forest

areas as available for active management, these alternatives would allow more treatments to occur where the forest restoration needs are the greatest. E-Modified and E-Modified Departure would incorporate a guideline in related to old forest harvesting that would allow flexibility to address other ecological needs of the forest. Alternative D would have no standards or guidelines restricting management within the dry upland old forests. As such, Alternatives D, E-Modified, and E-Modified Departure would also offer the greatest degrees of latitude in regard to doing treatments within old forest areas to promote greater resiliency.

These plan components will likely translate into lowered vegetation departure scores within the dry upland forest because more areas of old forest would be directly converted from multi-storied to single-storied conditions. Also, generally more areas would be thinned to promote development along a pathway to an eventual low density stand of old forest. The results of these alternatives compared to the most restrictive, namely Alternatives A and C, supports the idea that having more flexibility to use a wide array of management tools throughout a greater extent of the forest area, is more likely to promote ecological resilience of the forest vegetation. All of these alternatives effectively use these harvesting tools to emulate natural disturbance processes; however, Alternative D would not include prescribed burning outside of harvest units and would include decreased amounts of prescribed burning within harvest units. Under this alternative, the majority of fuels treatments within harvest units would be accomplished by removal or crushing instead of burning.

Although Alternative D is among the top three performing alternatives in terms of moving toward these desired conditions quickly, its lack of flexibility in regards to using wildland fire as a management tool may hinder its ability to maintain the desired conditions of the dry upland forest over time. Alternatives E-Modified and E-Modified Departure both include a much broader use of both planned ignitions and managed wildfire to aid in the restoration of key ecosystem processes. Mechanical treatments and fire both have the ability to change the density and structure of trees within stands in ways that can be tracked with a tool like the vegetation departure index, but wildland fire also plays a particularly critical role within the forests of the Blue Mountains in terms of many other key ecological processes. As dense understory reinitiation stages of the dry upland forest are moved into lower density single-storied forms by means such as thinning, wildland fire would be a useful complementary tool in terms of maintaining those conditions, and allowing those stands to eventually develop into the currently lacking old forest single-storied stages. Also, controlling potential fire behavior and promoting resistance to wildfire may be more effectively achieved with a combination of mechanical pretreatment along with prescribed fire, than with the use of either tool alone (Kalies and Yocum Kent 2016). Therefore, although the resulting departure index values are similar compared to Alternative D, either Alternative E-Modified or E-Modified Departure may result in a relatively higher level of ecological resiliency throughout the dry upland forest.

Number of Subwatersheds in Improved Watershed Condition Class

The analysis for the watershed section of this document computes watershed condition scores, which arrange between -1 and +1. The condition scores are divided into thirds with scores of less than -0.33 most likely to include watersheds in poor condition, scores of -0.33 to +0.33 most likely to represent watersheds in intermediate condition, and scores greater than +0.33 likely to represent watersheds in good condition. The method is intended to be analogous to watershed condition classes of impaired (Class 3), functional at risk (Class 2), and functional (Class 1), as used in the Watershed Condition Framework (USDA Forest Service 2011a). The number of watersheds improved is then computed as the sum of watersheds that change from condition class

3 to 2 and from 2 to 1, compared to existing conditions. The results, based on the results of the analysis of watershed conditions in this document, are displayed as the number of watersheds improved at year 10 in Table 129 and year 20 in Table 130.

Table 129. Number of subwatersheds in improved condition class in 10 years for each alternative for each national forest

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur	21	11	36	26	14	20	15	12
Umatilla	11	11	41	24	13	12	14	13
Wallowa-Whitman	4	19	33	12	15	5	7	14

At year 10, the higher number of watersheds improved is strongly influenced by the decrease in the area suitable for livestock in Alternative C and increase in suitable acres in Alternatives E-Modified and E-Modified Departure. Improvements in forest and riparian vegetation in Alternative C are sufficiently high that the higher level of stream and riparian restoration objectives in Alternative C results in a higher number if watersheds in improved condition. The number of watersheds improved in Alternative D is most related to improvement in forest vegetation conditions, in conjunction with the highest level of treatment of hydrologically connected roads.

Table 130. Number of subwatersheds in improved condition class in 20 years for each alternative for each national forest

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur	25	19	39	27	25	35	28	22
Umatilla	19	19	40	24	18	21	21	21
Wallowa-Whitman	6	21	36	15	17	13	8	17

The influence of increased rate of vegetation management and faster rate of improvement in the modified alternatives than in Alternative C results in a greater increase in the number of watersheds improved between years 10 and 20 in Alternative E-Modified relative to Alternative C on the Malheur National Forest. A similar change occurs on the Umatilla and Wallowa-Whitman National Forests between years 10 and 20 but the difference in the number of watersheds improved between Alternative C and Alternative E-Modified is greater than for the Malheur National Forest. Part of the difference is explained by the greater improved in the condition of dry forest and the greater extent of dry forest on the Malheur National Forest. Objectives for stream and riparian restoration are highest in Alternative C on all three forests, and the objectives for reducing road-stream connectivity are not high enough in Alternative E-Modified to offset these other differences. Further, the difference in livestock use between the modified alternatives and Alternative C is lowest on the Malheur National Forests resulting in greater difference between the alternatives on the Umatilla and Wallowa-Whitman National Forests.

Relative differences in the number of watersheds improved between Alternatives A and B are partially due to differences in suitable acres, stocking rates, and resulting livestock forage use between these two alternatives. In all alternatives, the number of watersheds improved is influenced by the choice of numeric breaks between condition classes, as described in this section, and the proximity of condition scores to the breaks between classes. This means that small improvements in overall condition may result in change in condition class when numeric condition scores are near the breaks between classes, and that greater improvement is needed to change condition class when numeric condition scores are substantially lower than the breaks between classes.

Summary of Key Indicators

Table 131 through Table 133 display a summary of the key indicators used in the analysis of ecological resilience. The values with asterisks depict the alternatives that result in either the greatest level of management activities designed to maintain or restore ecological resilience, or the greatest improvement in the key indicators used to reflect resilient conditions. Alternative E-Modified Departure would include the greatest number of acres of active restoration treatments per year, but this management regime is not projected to result in the best vegetation departure index values for the dry upland forest potential vegetation group at year 50. This alternative (E-Modified Departure) along with Alternatives D, E and E-Modified all make substantial and roughly equal progress moving forest vegetation composition, structures, and density closer to the historical range of variation.

Watershed conditions and the number of watersheds improved are evaluated by changes in forest vegetation departure, riparian vegetation departure, existing road density, reductions in road-stream connectivity, difference in livestock use, stream channel and riparian conditions, and objectives for stream channel and riparian restoration. Soil conditions are not treated directly, but roads and livestock use are correlated to or directly related to impacts to soils, and the alternatives with the highest levels of vegetation treatments also have the highest levels of impacts to soils.

Table 131. Summary of ecological resilience key indicators for the Malheur National Forest

Key Indicator	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Annual forest vegetation active restoration treatments (acres)	18,100	18,700	14,300	25,100	24,800	26,800	34,000*	20,100
Miles of road treatments (percent of roads in priority watersheds	NA	260 (23%)	600 (53%)	650 (58%)	290 (26%)	310 (27%)	300 (27%)	500 (44%)
Forage use intensity	23.5%	26.5%	14.2%	26.3%	26%	26%	26.5%	26.5%
Acres of riparian area improvement (percent of riparian areas improved)	NA	427 (25%)	941 (56%)	928 (55%)	639 (38%)	606 (36%)	639 (38%)	589 (35%)
Number of subwatersheds in improved condition	21	11	36	20	14	12	20	15
Departure index score within the dry upland forest at year 50	48	46	50	34	38	37	36	43

Table 132. Summary of ecological resilience key indicators for the Umatilla National Forest

Key Indicator	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Annual forest vegetation active restoration treatment (acres)	16,950	17,400	14,000	20,100	20,200	19,800	26,700	18,700
Miles of road treatments (10 yrs)	NA	260 (83%)	400 (128%)	800 (257%)	300 (96%)	270 (87%)	350 (112%)	600 (193)
Forage use intensity	10.6%	10%	1.4%	10.1%	10.1%	10.1%	13.7%	13.7%
Acres of riparian area improvement (percent of riparian areas improved) 10 yrs	NA	368 (49%)	831 (112%)	619 (83%)	551 (74%)	523 (70%)	550 (74%)	524 (70%)
Number of subwatersheds in improved condition (year 10)	11	11	41	24	13	13	12	14
Departure index score within the dry upland forest at year 50	48	47	52	40	41	40	40	44

Table 133. Summary of ecological resilience key indicators for the Wallowa-Whitman National Forest

Key Indicator	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Annual forest vegetation active restoration treatments (acres)	17,650	18,150	14,450	22,650	23,450	22,600	29,800	19,850
Miles of road treatments (10 yrs)	NA	260 (38%)	400 (59%)	800 (118%)	300 (44%)	270 (40%)	350 (52%)	600 (89%)
Forage use intensity	21%	20%	9%	21%	20%	25%	25%	20%
Acres of riparian area improvement (percent of riparian areas improved) 10 yrs	NA	473 (37%)	1,039 (81%)	824 (64%)	708 (55%)	631 (49%)	708 (55%)	632 (49%)
Number of subwatersheds in improved condition (year 10)	4	19	33	12	15	14	5	7
Departure index score within the dry upland forest at year 50	54	52	55	45	45	45	45	50

All of this being said, improvements in vegetation condition are reflected and are more apparent in overall watershed conditions and in the number of watersheds improved at year 20 than in year 10. This is because of different apparent rates of change in vegetation conditions between the alternatives and different initial conditions of the three dominant forest potential vegetation groups on the three National Forests.

Improved upland vegetation conditions, reduced road-stream connectivity, reductions in livestock use, and lesser impacts to soils in Alternative C should reflect a more rapid improvement in hillslope processes that control the rate at which water is concentrated in streams. This should alleviate the impacts that upslope conditions have on riparian areas, stream channels, and aquatic habitats.

Relatively more importance is given to riparian areas in evaluating overall watershed conditions because past land uses have had relatively more effect on riparian areas and because of the role riparian areas serve in regulating the interactions between streams and adjacent hillslopes, and because of the influence that riparian areas have on stream and aquatic habitat conditions.

The potential higher effects to soils in the alternatives that would have high levels of vegetation treatments can be offset or mitigated by implementing best management practices, adherence to soil quality standards, and increased emphasis on restoring soil function when impacts do occur.

These results show a positive correlation between the degree of active vegetation restoration treatments and improvements in the resilience indicators. However, the relationship may weaken beyond a certain threshold that is crossed by Alternative E-Modified Departure. Thinning regimes are limited, to some extent in their ability to improve departure index values because in the near and mid-term time frames they tend to trade an overrepresentation of dense mid-aged structures for a corresponding overrepresentation of open mid-aged structures. The departure index values may tend to miss some of the significance in terms of the changes expected within the dry upland forest.

The alternatives that are more aggressive with active restoration would thin a large amount of what is now dense, mid-aged stages, and thus convert it to low-density mid-aged stages. In the near term, when looking just at departure index values as a metric, this merely results in a swap of a large variation in the dense stages for a corresponding large variation in low-density stages. However, the low-density stages of the dry upland forest would likely represent a much more stable condition, less prone to atypical severe wildfire behavior. The low-density stages would also be poised to develop directly into future single-storied old forest stages, which are currently severely lacking. The denser forms of dry upland forests are very vulnerable to excessive fire behaviors and bark beetle outbreaks, and even if they avoid severe disturbance, they are likely to eventually develop into multi-storied old forest stages, which are already reasonably well represented on the landscape.

Alternatives like E-Modified and E-Modified Departure, which reduce the overstocked dry upland forests the most, may be superior options for the Blue Mountains national forests in light of these considerations.

There are limits to what active vegetation management can accomplish in terms of restoring resilience. One of the biggest issues within the dry upland forest in terms of ecological resilience is the lack of old mature forest structures. Thinning and uneven-aged harvesting can help maintain old forest and facilitate its eventual development, but it cannot speed up the maturing and aging process itself. Since the time required to develop is one of the biggest factors limiting the long-term rate of old forest restoration, increasing the rate of thinning may only go so far in terms of achieving the overall restoration goals for dry old forest.

Resilient landscapes have a greater capacity to survive natural disturbances and large-scale threats to sustainability, especially under changing and uncertain future environmental conditions, such as those driven by climate change and increasing human uses. The ecological resilience issue is complex, involving physical and biological factors as well as human actions. Risks to resilience arise from many sources, both natural and human caused. Reducing risks in one component of the ecosystem may increase risks in others. No one alternative best addresses the issue of ecological resilience. Reliance on natural processes may be the fastest way to achieve desired conditions for some ecosystem components, while others components may require active restoration.

Ecological Resilience– Cumulative Effects

Potential cumulative effects were analyzed by considering the effects of the alternatives in the context of past, present (ongoing), and reasonably foreseeable future activities that have occurred within the vegetation and hydrological cumulative effects analysis areas. This analysis area

consists of the 25 subbasins that contain the Malheur, Umatilla, and Wallowa-Whitman National Forests and other lands. The time period into the future considered was 50 years. Present and foreseeable future activities that could affect forest vegetation are summarized below.

Continuing to implement levels of silvicultural restoration treatments under management direction similar to the current plans (i.e., Alternative A), is likely to result in a slower rate of movement toward more resilient conditions than most of the other alternatives offer. One possible reason for this may be because much of the direction currently contained in the forest plans lacks an integrated approach. The specific objectives addressed by some of the major plan amendments like the Eastside Screens, PACFISH and INFISH, have overlaid and diverged to some extent from some of the original goals of the 1990s plans. Treatments and area priorities have often been designed to minimize conflicts, making integrated project planning difficult. The resulting abundance of relatively small-scale implementation projects designed for specific purposes, has largely been insufficient in terms of rapidly moving substantial areas of the forest landscapes toward more resilient conditions.

One notable exception to this pattern, however, has been the award of a large-scale 10-year Integrated Resource Service Contract by the Malheur National Forest in 2013. This 10-year contractual obligation to supply substantial volumes of biomass and timber to contractors will likely provide additional momentum to the planning and implementation of forest restoration projects by the Malheur National Forest for at least the remaining term of the contract. These types of projects utilize Stewardship authority, which allows the revenues from commercially viable treatment by-products to fund other ecologically critical restoration activities like fish passage enhancements, non-commercial thinning and stream and spring restoration projects. This general approach, of designing larger projects that are more fully integrated across multiple resource areas based on ecological needs, should be well supported under the direction of the final revised Forest Plans. The plan direction will facilitate integrating priority watershed work into the planning process, and the incorporation of best available science into the design of plan components should simplify future project level planning.

The greatest source of foreseeable actions connected to future forest and ecosystem restoration treatments within the Blue Mountains national forests are related to the ongoing Eastside Restoration Strategy. This effort supported by the Pacific Northwest Regional office of the Forest Service started in 2013 as a way of putting resources and a focus on some different ways of planning and implementing forest restoration projects on the eastside National Forests of Oregon and Washington. Since 2013, the effort has supported the development of five Collaborative Forest Landscape Restoration projects and five Joint Chief's projects, which combine the forces of the Forest Service and the Natural Resources Conservation Service to restore forests and reduce fuel loadings across adjoining Federal/non-Federal lands in priority areas. The Blue Mountains Restoration Team has recently completed the Lower Joseph Creek Restoration Project Final Environmental Impact Statement and the Record of Decision for that implementation project was finalized in March of 2017. The same team is currently working on the landscape scale Blue Mountains Forest Resiliency Project, which encompasses parts of four national forests in the Blue Mountains of Oregon and may result in the site-specific authorization of up to 610,000 acres of thinning and prescribed fire treatments. All of these planning efforts will tend to support the future implementation of the revised Forest Plans.

Cumulative Effects Related to Watersheds

Other actions on the National Forests include area-wide forest vegetation management described above; continued implementation of stream, riparian, and aquatic habitat restoration; replacement and redesign of stream crossing culverts to restore fish passage and extend the habitat available to aquatic species; and implementation of actions cited in recovery plans for federally listed fish species by the Forest Service, State agencies, Tribes, and watershed councils. Active riparian, stream channel, and aquatic habitat restoration is occurring and will continue to occur in every river basin encompassed by the national forests in the Blue Mountains, including areas downstream of the National Forests.

A high percentage of streams on National Forest System lands have been degraded by land uses that in some cases extend back nearly 200 years, but the most intense effects of land use began settlement of the Blue Mountains by Euro-Americans after about 1850. Past actions include removal of beaver, placer mining, stream channelization, water diversions, conversion of floodplain vegetation to livestock pastures and irrigated agriculture, log drives, railroads, logging of riparian trees, roads, and removal of large wood from streams. The time period required to fully recover from the effects of these legacy land uses is often longer than the time period between large floods and suggests that recovery of some streams will not be linear, but will be punctuated by adverse effects from future floods.

Actions that restore vegetation conditions, ground cover, soil conditions, and reduce the hydrologic effects of national forest roads will benefit watershed conditions by decreasing the rate of watershed runoff and reducing the effect of past forest management on the magnitude of peak flows. Actions that restore riparian vegetative conditions will enhance stream channel stability and improve aquatic habitat complexity and productivity.

Actions that reduce the effects of national forest roads are expected to result in substantial improvements in watershed condition and water quality by reducing runoff rates, surface erosion from forest roads, and resulting sediment delivery to streams.

Existing data suggests a large difference in the frequency and volume of instream wood between managed stream in the Blue Mountains and reference streams in the Columbia River Basin, including sites in the Blue Mountains. Removal of instream wood has resulted in degradation of stream channels, conversion of some gravel-bed streams to bedrock streams, and reduced the quality of and complexity of aquatic habitats. The difference in large wood volume between reference and managed streams is on the order of 17,000 to 50,000 board-feet per mile. Over 9,000 perennial stream miles on National Forest System lands, this difference equates to a deficit of instream wood in the range of 150 million to 450 million board feet. The effect of this loss is exacerbated by the fact that more early logging occurred in riparian areas because they were easier to access and logs were easier to transport.

Considering the effects of changes in vegetation departure, riparian conditions, and stream channel conditions, Alternative C would result in the most watersheds improved (39) and greatest improvement in watershed conditions on the Malheur National Forest within 10 years, followed by Alternative E-Modified (30 watersheds improved). On the Umatilla National Forest, Alternative C would result in 41 watersheds improved compared to 24 in Alternative D. On the Wallowa-Whitman National Forest Alternative C would result in 33 watersheds improved compared to 19 in Alternative B, and 5 in Alternative E-Modified in 10 years. The modified alternatives tend to result in faster rates of movement towards desired conditions between years 10 and 20, with the absolute rate varying by forest. The mix of harvest rates, reduction of road-

stream connectivity, reduced extent of grazing, and higher stream channel and riparian restoration objectives result in greater improvements in watersheds conditions in Alternative C. The same factors result in nearly the same level of improvement in Alternative E-Modified. Any increase in the rate of reduction of road-stream connectivity would result in faster improvement in stream channel, riparian, water quality, and aquatic habitat conditions and this could result in Alternative E-modified approaching the same level of watershed improvement as Alternative C, especially on the Malheur National Forest where existing road densities are the highest among the three forests.

Physical Environment

Soils

Changes Made Between the Draft and Final Environmental Impact Statements

Aside from changes described in the Preface to this document, the following changes were made specifically to this section:

Changes to the Analysis: Additional background and context information was provided regarding methodology of soils data use and assumptions. Public comments received on the Draft Plan and Environmental Impact Statement regarding the use of the generalized land type associations drew questions and misconceptions regarding soils information used in the analysis. It also seemed to generate some questions about how soils information will be used in planning and implementation of future projects. It was apparent that providing additional information and improving the clarity of this section would help readers and stakeholders understand the definitions, ideas, and context surrounding these processes.

Discussions of landform instability was added to the analysis and to the standards and guidelines of the revised plan. While landform stability is characteristically included at the onset of planned projects, comments regarding an absence of measure prompted its inclusion in the final standards and guidelines.

Introduction

The Forest Service Manual, Chapter 2550 - Soil Management directs soil resource management on National Forest System lands. The objectives of the national direction are (1) to maintain or restore soil quality on National Forest System lands and (2) to manage resource uses and soil resources on National Forest System lands to sustain ecological processes and function so that desired ecosystem services are provided in perpetuity. Soil function is any ecological service, role, or task that soil performs. The Manual identifies six soil functions: soil biology, soil hydrology, nutrient cycling, carbon storage, soil stability and support, and filtering and buffering. In order to manage multiple use and ecosystem services in perpetuity, these six soil functions need to be active and effectively working. Each of these six soil functions are discussed in the following sections.

Individual soils types are a product of geologic parent material as modified by the effects of weather, topography, biota, and time (Jenny 1941). Paul and Clark (1996) expand the definition of biota to include above ground vegetation as well as the variety of soil organisms responsible

for nutrient exchange between soils and vegetation and the decomposition of organic material responsible for the development of upper soil horizons.

The Blue Mountains national forests encompass a large geographic area with a variety of geologic parent materials, including both bedrock and surficial geologic features. Such features include basic igneous rocks, clay producing deposits, acid igneous rocks, lakebed sediments, metamorphic rocks, and sedimentary rocks. It also includes glacial deposits (till, outwash), recent and old alluvium, and aerially deposited materials, such as loess and volcanic ash. All have been modified to a degree by the actions of wind, water, gravity, and vegetation over time resulting in the wide variety of taxonomically defined soils present today.

The Blue Mountains physiographic province, which includes the Blue Mountains national forests, is characterized by a diverse landscape ranging from river and valley bottoms to steep mountain slopes, deeply dissected canyons, and mountain and plateau tops (Sasich 2006). Landform type and topography directly influence soil characteristics and productivity and erosional, depositional, sedimentation, and hydrologic processes; specifically mass wasting, surface erosion, and runoff (Sasich 2006). Individual soils are a product of geologic parent material being modified by the effects of weather, topography, biota, and time (Brady 1990). Soils store and provide water and nutrients for vegetation. This storage also comes from absorption of precipitation and to a degree the storage also regulates quantity and timing of stream flows; providing for a wide variety of wildlife habitats (above and below ground). The soil also helps to buffer against ambient climate extremes, while storing and regulating release of carbon (Lal 2008). Other resource values, such water quality, quantity, wildlife habitat, and biomass production, are often dependent on and closely related to properly functioning soil conditions.

Soil moisture and temperature have always influenced each soil’s productive potential and how plants respond to disturbances, and they are predicted to be especially important to future conditions for soils and vegetation as well (Halofsky and Peterson 2017). Given the variation in topography and atmospheric moisture within the Blue Mountains, there is a consequent variation in local climatic conditions. Diurnal fluctuations in both temperature and moisture are also important environmental variables and are influenced by elevation and aspect. Soil moisture and temperature regimes are reflected by the kinds of vegetation occurring on a landscape, but some microsite vegetation conditions may not always be reflective of soil moisture and temperature. Management activities (vegetation management and surface soil removal) can influence yearly and daily fluctuations in temperature and moisture of the soil resource.

The five soil forming factors help us understand soil developmental processes (Jenny 1941, Meurisse et al. 1990). The development of soil is used to help define its taxonomic class. Beginning with the broadest to most detailed taxonomic classes are order, suborder, great group, subgroup, family, and series. Each level of taxonomic class gives more detailed information about the soil. Within soil taxonomy there are 12 orders of soil taxonomy, each order is based on one or two dominant physical, chemical or biological properties to differentiate one from another. The most common soil order to the Blue Mountains landtype associations are: Andisols (volcanic ejecta), Entisols (Embryonic [early] development, no B horizon), Inceptisols (poor development with a B horizon), Alfisols (developed under forests) and Mollisols (typically developed under grasslands). These soil orders are referenced to the soil classifications mentioned in the Sasich (2006), by the soil series associated with the landtype association mapping. It should be noted that this mapping is a generalization of the soils mapped in the area.

The generalized mapping in the landtype association identifies four soil orders, while the soil orders in the Blue Mountains; Entisols, Inceptisols and Alfisol soils are common to forested ecosystems. Mollisols typically developed under a grass dominated ecosystem.

Another soil order not identified within the landtype association, but mapped in the Blue Mountain Terrestrial Ecological Unit Inventory, are Histisols (more than 20 percent organic matter, such as peat soils). Histisols have a limited presence in the Blue Mountains and have developed where temperatures are low and moisture is high; commonly high elevation meadow sites. It is very likely that these soils play a role in riparian habitat since they are commonly associated with wet meadows.

Defined as having a high base cation saturation and high organic content (USDA NRCS 2010), Mollisols may develop under a forested environment, but only if topographic features allow organic matter accumulations (wetlands or stands on a concave surface) (Brady 1990). Vegetation species can help build organic accumulations in the soil, like deciduous trees or peat associated to Histisols development. Given these topographic limitations, we can infer that Mollisols in the Blue Mountains; on convex surfaces (ridge and shoulder slope positions) or linear (flat or mid-slope) landforms developed under a grass dominated condition. The reason we assume Mollisols on convex and linear landforms developed under grasses, is due to the low organic inputs from forested environments and the high cation and organic content needed to classify a soil as a Mollisol (Brady 1990). Despite their grassland development, some of these Mollisols currently support forested conditions. So it is probable these forest stands having encroached on the nutrient rich, sparsely timbered open savannah soils, some of which are shallow soils with elevated drought potential. Other important soil properties include soil depth, organic matter content, nutrient content, ground cover (litter), soil texture, water holding capacity, and infiltration capacity, all of which have biological and physical importance (Childs et al. 1989, Meurisse et al. 1990). Soil properties vary greatly across the landscape and between different soil types, influencing the forest vegetation’s presence or diversity.

Decomposition of organic material and mineralogy is the principal source of nutrients in soil and varies with vegetation type, stand age, species composition, and fire history (Jurgensen et al. 1997). This decomposition accumulates organic matter content within the soil horizons. In forested watersheds, wildfires aid in decomposition and were historically important in creating vegetative patches of differing plant community types and stages of succession, as well as in ensuring the availability and recycling of nutrients to the soil (Smith et al. 2017).

Figure 23 is a generalization of organic matter, below ground for a forest and grassland environment; both conditions are present within the Blue Mountains range. This is an important condition to understand when considering the issues of wildfire, climate change, and the droughty nature of the soil. Soil organic matter stores water in the soil and slowly releases the water to plants that can then release the water to the atmosphere (via evapotranspiration). Soil organic matter can also aid in water release to streams and rivers.

Total biomass or above ground biomass is not shown in the figure, but it is commonly understood that the bulk of total biomass within the forest is held above ground. If the above ground biomass is killed by a stand-replacing disturbance (such as wildfire), the biomass not consumed in the fire will then begin to decompose and to release stored carbon in various forms. At the same time, the below ground biomass killed from this same disturbance will also decompose and similarly add to the release of stored carbon. This release will continue until or if recovery of the forest vegetation

takes up the carbon losses as new vegetation consumes the decomposition material. Depending upon the intensity of the disturbance, the return of new vegetation cannot always be assumed.

Considering Figure 23, the wildfire effects to grassland and forest, mostly affect the above ground organic stores. While some fires can detrimentally influence grassland conditions, the results are often variable (Neary and Leonard 2015). As can be seen in the figure above, the majority of the grass plant biomass is below ground material and at a reduced vulnerability of loss to wildfire. Therefore, if the soil is not heat altered; the roots of disturbed vegetation are largely unharmed and vegetative recovery following most wildfires is very fast.

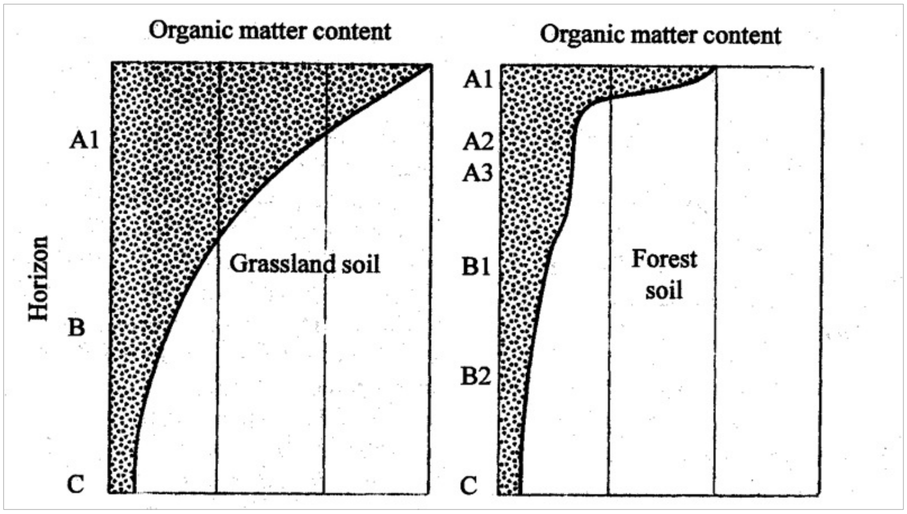


Figure 23. Grassland soil profiles contain about twice as much organic matter that is uniformly distributed through the soil profile than forest soils under similar conditions (Foth 1978)

The same is not true in the forest; a high intensity fire can kill stands without heat alteration of roots or soil, or canopy loss. Stands killed by wildfire are then subjected to decomposition, where a small portion may be returned to the soil. Recognizing this condition implies a need to limit fire effects within forested areas, but it also offers a reason to minimize the decline and forest encroachment of grass dominated environments within the Blue Mountains.

Methods

A summary of general soil types in the Blue Mountains are mapped by landtype associations description, within the 2006 Landtype Association of Blue Mountains Ecoregion In Oregon and Washington (Malheur, Umatilla, Wallowa-Whitman and a portion of Ochoco National Forests) (Sasich 2006). This mapping is also available in an associated Geographic Information System (GIS) layer. The landtype association information was used due to its complete coverage across the analysis area and consistent nomenclature, allowing better delineation of the effects of management objectives. Landtype associations are differentiated based on (1) vegetation zones, (2) geology groups, and (3) landforms. There are 80 landtype associations in the Blue Mountains. In addition to the three characteristics that differentiate the landtype associations, Sacich (2006) gives information on volcanic ash, texture, rock fragments, depth to bedrock, soil climate, hydrologic and sedimentation properties and responses, productivity, vegetation recovery, limitations for roads and heavy machinery operability, timber and range suitability, and other characteristics.

Detailed, site-specific soil information consistent with the landtype association mapping will be used in the planning and implementation of individual projects. Beginning in the 1990s, a new soils survey began across the Blue Mountains for the Malheur, Umatilla, and Wallowa-Whitman National Forests. The Blue Mountains Terrestrial Ecological Unit Inventory is available in a GIS layer and database. The inventory will improve soil knowledge and planning within the Blue Mountains, offering greater detail and an improved understanding of soil formation within the area. An example of how this inventory data might improve the understanding of the forest, is the use of "A taxonomically based ordinal estimate of soil productivity for landscape-scale analyses" (Schaetzl 2012), to recognize soil productivity differences across the forest.

Detrimental Soil Conditions

Fundamental to sustainable use of National Forest System lands is the ability to assess relative risk, or lack thereof, for site-specific proposed activities (Reynolds et al. 2011). This strategy recognizes that potential risk of a given action or inaction (hazard of impact and consequences of that impact) depends on numerous site specific factors and climatic conditions before and after the activity. Complexity of interactions among activities, local conditions, and on-site and off-site consequences must be recognized. A part of the assessment for this soils report is to estimate the risk of incurring soil damage; which will be referred to as detrimental soil conditions. By understanding the potential risk from detrimental soil conditions to the soil resource, an activities impact can be assessed and mitigations can be prescribed and implemented.

In evaluating the potential effects of the alternatives on soils, a comparison of the total acres that would be treated for each activity is used. To estimate the amount of detrimental soil conditions resulting from those activities during the life of this plan, the number of potential detrimental soil condition acres are calculated using the following formula:

> Annual = existing detrimental disturbance (assumed or validated) + acres of activity x expected soil disturbance of specific treatment

The soil disturbance factor for timber management activities is displayed in Table 134. Acres of activity by national forest and alternative are on an annual basis, displayed in Table 136.

Table 134. Potential area extent of new detrimental soil conditions associated with timber management activities proposed for all alternatives

Timber Management Activity	Detrimental Soil Conditions
Even-aged harvest with ground-based system	15 percent
Even-aged harvest with cable logging system	6 percent
Uneven-aged harvest with ground-based system	8 percent
Non-commercial thinning and mechanical fuels treatment	5 percent

The estimated amount of detrimental soil conditions are calculated assuming approximately 90 percent of the even-aged harvest treatment acres would be harvested using a ground-based logging systems and the remaining 10 percent with a cable logging systems. Acres that would be treated are assumed to be equally distributed across MA 4A General Forest, but not equally distributed across potential vegetation groups. It is estimated that 60 to 90 percent of the timber harvest activities will take place within dry forest potential vegetation groups (see Table 143).

Plan Components for Soils

The plan components for the soil resource included desired condition, which are expected to frame the sustainable conditions for the Blue Mountains. Also included in these components are soils standards which are expected to specify limits to either maintain or attain desired conditions as well as a monitoring component to the soil resource in addition to other Forest Service Manual directions. Monitoring will help to offer adaptive management options to planners at the next forest plan revision.

Desired Conditions

1. The productive potential of forest and range soils is maintained at levels that contribute to long-term sustainability of ecosystems considering the range of possible climate change scenarios. Conserving soil function so that management activities do not impair long-term soil and site productivity.
2. Soil physical and chemical properties of texture, porosity, strength, and fertility, as it may pertain to organic matter (surface and subsurface accumulations) are at levels that maintain soil potential productivity and hydrologic function (infiltration, percolation, and runoff).
3. Surface erosion rates and sediment deposition are within the natural range of variability for each biophysical setting. Where and when needed, use an appropriate amount of effective ground cover in the form of live and dead vegetation.

Standards

1. Activities with the potential to cause a reduction of soil productivity (detrimental compaction, displacement, puddling, and severe burning), shall meet the following requirements:

   Following completion of management activities an activity area will have less than 20% detrimental soil conditions from the recent managed activities. In an activity areas where existing detrimental conditions exceed 20% alone or in combination with proposed activities; the management activities shall include mitigation and/or restoration so at the completion of activities the area will have less than 20% detrimental soil conditions.

2. Management actions should neither degrade nor retard attainment of properly functioning soil, water, riparian, and aquatic desired conditions, except:
   a. Where demonstrable short- or long-term benefits to soil resource conditions occur; or
   b. Where the Forest Service has limited authority (e.g., private land access roads, hydropower, etc.), the Forest Service shall work with permittee/landowner(s) to minimize the degradation of watershed resource conditions.
3. After completion of management activities the minimum effective ground cover shall be in place to prevent erosion from exceeding background soil erosion rates characteristic to the forest and local climate. Table 135 shows expected effective ground cover rates.

Table 135. Minimum percent effective ground cover in the first and second years after an activity for each erosion class rating

Erosion Hazard Class	Required Minimum Percent Effective Ground Cover After Activity Year 1	Required Minimum Percent Effective Ground Cover After Activity Year 2
Low (Very Slight Risk)	20-30	30-40
Medium (Moderate Risk)	31-45	41-60
High (Severe Risk)	46-60	61-75
Very High (Very Severe Risk)	61-75	76-90

4. Site-specific analysis or Forest Service approved field verification of broad-scale landslide-prone models shall be conducted in representative areas that are identified as landslide prone during site/project-scale analysis involving proposed management actions that may alter soil-hydrologic processes. Management actions will be designed to avoid the potential for triggering landslides.
5. Activities within riparian management area floodplains and wetlands should prevent soil movement or alteration of site conditions that degrade water quality. Maintain these areas where human activity has contributed to drying these types of soils; return the soil/water function to previous conditions.
6. Where proposed management actions may alter soil-hydrologic processes, representative sample of landslides and landslide-prone areas should be field-verified to identify and interpret controlling and contributing factors of slope stability. Integrate the resulting information with supporting data to provide a final stability assessment and identification of appropriate land management actions in landslide and landslide-prone areas.

Biological Soil Crusts

In areas where organic matter is slow to accumulate, Biological soil crusts are critical for stabilizing the mineral soil surface and trapping sediment in forested and non-forested sites. These crusts are not considered to be physical (erosion deposition) or chemical (precipitated high salt content) in their development (NRCS 2008). These crusts can be found in arid and semi-arid shrublands, grasslands and forests. Biological soil crusts function as living mulch, helping to retain soil moisture and are recognized as discouraging annual weed growth of moisture stressed sites (Belnap et al. 2001). Disturbances, such as: livestock grazing, fire, seasonal use by wild ungulates, natural erosion processes (specifically sheet erosion), and off road vehicle use contribute to a complex mosaic of biological soil crust composition or absence. Frequent or continuous disturbance from any of the previously mentioned disturbances, will keep the biological soil crust communities at an early successional stage (Belnap et al. 2001), limiting its benefit to weed abatement. The degree of degradation for biological soil crusts is related to disturbance intensity, soil type (specifically soil texture) and site soil moisture availability.

Soil Disturbance

All detrimental soil conditions come from soil disturbance, but not all disturbance is detrimental. Soils developed under disturbances from fire, land instability (rock and soil) and various other forms of deposition. Volcanic deposits are present throughout the Blue Mountains (Sasich 2006), and are considered beneficial to soil productivity today. Of the disturbances with detrimental effects, vegetation management, mining, recreation, and rangeland grazing are the most common in the Blue Mountains. Soils are monitored for the level of disturbance from humans or animals.

Detrimental soil conditions are often where soils have lower levels of resilience, allowing detrimental conditions to further limit the soil resource (Jang et al. 2015). Therefore, detrimental soil conditions that alter soil productivity must be limited in an area and minimized where feasible by impact(s).

Soils – Affected Environment

Soils are a major component of ecological integrity and often present unique challenges to land managers. Detrimental soil conditions have influenced soil quality in the analysis area to varying degrees by past managed multiple-use activities such as timber harvests, fuels reduction activities, road and trail construction, mining, grazing, wildland fire suppression (and exclusion) activities, and various recreation activities including off road motor vehicle use, as well as unintended actions such as the introduction of invasive plant species. Other sources include natural events such as wildfire, storm (i.e., rain- on-snow) events, landslides, floods, and insect and disease outbreaks (Hessburg et al. 2005, Hessburg and Agee 2003, Langston 1995, Lehmkuhl et al. 1994, Mutch et al. 1993, Rainville et al. 2008).

Results from disturbance that create detrimental soil conditions include processes such as compaction, displacement, and erosion that can occur from any of the above mentioned sources. The effects of these activities and how long they last on the soil resource depends on site factors like soil characteristics, vegetative conditions (species, diversity, and amount of residual cover), and the intensity or force of the activity. In addition to altering soil productivity, the activities that create detrimental disturbance can have other subsequent effects such as generating gullies, becoming the catalyst for streambank failures or landslides, eroding roads, impeding stream flow, etc. These disturbance agents, in conjunction with variation in soils and microclimate, create mosaics and heterogeneity throughout all dominant vegetation associations (Jaindl et al. 1996, Johnson 1994, Johnson et al. 1994).

Often upland meadows and range sites are buffered by forest or productive range, which can limit chronic sediment delivery to streams and rivers. Separate from upland locations, in some riparian areas, gullying or stream entrenchment has lowered water tables, affecting available soil moisture and may be a source of sediment when stream banks are compromised by animal, or human disturbance. From time to time, undercut stream banks or those with little soil cohesion may fail due to stream alterations from climatic variation in water level of flow in the waterway.

The 2001 monitoring report for the national forests documented evaluations of soil conditions on several planned and completed projects. Within the Malheur National Forest, all but 4 of the 18 units sampled had less than the forest plan mandated 20 percent maximum detrimental soil impact. Over-the-snow operations resulted in greatly reduced detrimental soil conditions versus levels resulting from dry season operations. Some locations within the Blue Mountains may be able to rely on this beneficial soil tactic for harvest, but not all locations receive winter conditions suitable for this benefit.

Even though there was a concern for cumulative legacy effects, the Umatilla National Forest five-year evaluation of soil conditions in 2001 documented that those areas associated with the legacy effects were scattered, involved relatively little land area, and showed few signs of productivity problems or erosion problems. Adjustments in treatment methods made after the 1990 Forest Plan was implemented resulted in a reduction in detrimental impacts to soils. No sampled units exceeded the Plan thresholds for detrimental soil conditions.

Pre-activity surveys for the Wallowa-Whitman National Forest documented that all but one proposed timber sale project areas had some units that exceeded the threshold (exact statistics were not disclosed). To improve soil conditions (generally for compaction) subsoiling has been used. Subsoiling within the Blue Mountains has been successful in enhancing the soil recovery process, which is consistent with various authors (Heninger et al. 2002, Craigg 2000 and Luce 1997).

Donnegan et al. (2008) used data from the national Forest Inventory and Analysis, which included soils, to summarize the status of Oregon's natural resources. The data on existing area compaction indicated that about 7 percent of the plots in the Blue Mountains showed compaction levels of 15 to 30 percent at the inventory plot. There was no indication of whether the 15 to 30 percent of a plot showing compaction was actually detrimental compaction. Eighty-one percent of the plots showed levels of zero to 5 percent compaction. Approximately 12 percent of the plots showed compaction levels of 5 to 15 percent.

Timber Harvest Effects

The trends in existing conditions are described for two eras of timber harvest practices. The first timber harvest era is before 1990. The second timber harvest era is 1990 to present. Prior to 1990, the three National Forests offered timber sales on large tracts of land where heavy logging occurred from approximately the 1920s to the late 1980s. Timber harvest activities included the harvesting and removal of large diameter trees (often old growth ponderosa pine) with ground-based, rubber-tired tractors and skidders, and preparation and sanitization for re-planting by tractor piling, brush piling, and burning of slash residue piles. In many cases before the 1990s, designated skidding was not used. Further site preparation for replanting trees would often include post-harvest broadcast burning.

The second timber harvest era is a result of the National Forest Management Act of 1976, which included policies and guidelines directing that National Forest System lands be managed to maintain their productive potential. Compliance with the new policies was to be shown through implementation, effectiveness, and validation (research) monitoring results. The National Forest Management Act resulted in a dramatic change in design criteria and the types of constraints or mitigations, technology, and restoration activities needed to comply with revised Forest Service direction and policies (USDA Forest Service 1990), including:

- Increased skid trail and road spacing
- Reduced equipment ground passes
- Use of low ground pressure, ground-based machinery, including mechanical processers and loaders/forwarders
- Change in season of operation to limit timber harvest activities to when soils are either dry or frozen
- Use of whole-tree yarding
- Hand piling and burning of small piles
- Seasonal prescribed burning to reduce disturbance from slash reduction and site prep
- Implementation of subsoiling to ameliorate soil compaction effects for improvement of soil productivity, stand regeneration, and hydrologic processes

In the late 1900s, timber managers throughout the Blue Mountains were also faced with increased forest health issues and wildfire concerns (Everett et al. 1994). The resultant management of large

acreages of overstocked stands required the use of efficient, less costly, low ground pressure mechanized harvest and yarding equipment to thin overstocked stands, harvest timber, and the use of prescribed fire to reduce fuel loads and fire hazards. Research and local soil monitoring summarized in the following pages indicate a corresponding overall reduction in adverse soil impacts to the soils during the second era (USDA Forest Service 2001c).

From the late 1920s to approximately the early 1990s, management focused on regeneration harvest activities and or/selection harvest activities to remove large diameter trees with high ground pressure, ground-based equipment and intense site sanitation and seedbed preparation techniques. Research and monitoring surveys estimated the amount of detrimental soil conditions throughout the Blue Mountains national forests to range from approximately 17 percent to greater than 55 percent of an individual activity area. These values exceed or come close to the threshold of no more than 20 percent of an activity area resulting in detrimental soil disturbance specified by regional guidance and revised forest plans (USDA Forest Service 1998). Harkenrider (Grape Unit 2 in 1979) found that a clearcut lodgepole pine stand within the La Grande Ranger District that was harvested with a feller-buncher, yarded to a landing with a rubber-tired skidder, and slash dozer-piled and burned resulted in approximately 55 percent of the area’s soils detrimentally compacted.

Sullivan (1988) found that 15 of 24 timber harvest units had post activity soil impacts that exceeded the regional standard of 20 percent of the area, and another 5 units had soil impacts on more than 15 percent of their area. It is unclear if a single factor precipitated these conditions. The common factors to the detrimental soil conditions are: (1) ground-based equipment operation on wet or moist soils and (2) failure to use slash to buffer equipment weights.

In the early 1990s, harvest activities focused on use of new technologies and project design criteria to comply with revised management direction and policies (USDA Forest Service 1990). Commonly used design criteria included designated skid trail spacing, low ground pressure machinery, mechanical harvesters, processers and loaders/forwarders, season of operation, operating over frozen ground, snow and slash, hand piling of slash, and restoration (including subsoiling). After 1990, research and local soil monitoring results (USDA Forest Service 2001) indicate that the use of updated technology corresponds to an overall reduction in areal extent of detrimental soil disturbance and often results in compliance with the standard of no more than 20 percent of an activity area’s soils being detrimentally impacted (USDA Forest Service 1998).

Published data for detrimental soil compaction from timber harvest activities range from approximately 5 to 30 percent of an area. Areas in the high end of the range were generally harvested in the mid to late 1990s, while areas in the low end of the range were generally harvested from the late 1990s to early 2000s. Less detrimental impacts are generally attributed to the use of multiple mitigation measures to limit soil disturbance. The variation is generally attributed to implementation of project design criteria, including the spacing of skid trails, activities with dry conditions and type equipment used. Soil disturbance characteristics can occur in thinning harvests, regeneration cuts, and partial cuts, but in higher frequency when ground-based equipment is used. Although traffic patterns are likely to be less concentrated in partial cut activities, resulting in less soil impacts overall (Page-Dumroese et al. 2009, Miller et al. 2010); impacts are less in the activity area overall, but just as detrimental in the equipment footprint. This trend is indicated in the research findings, where lower areal extent of detrimental soil conditions is generally associated with thinning operations (Bliss 2006, McIver et al. 2003, and McIver 1998), operating over snow (Craigg and Howes 2007), or use of a skyline logging system

(Allen et al. 1999). Some authors also postulate that thinning can be a positive activity to soils if fine organic materials are left on the soil surface (Klock 1982) after harvest.

Allen and Adams (1997) found that thinning of second-growth Douglas-fir with a skyline logging system resulted in only 2 percent of the area soil being detrimentally disturbed. McIver (1998) found that 6 of 7 thinning units on the Wallowa-Whitman National Forest had total disturbance levels of less than 10 percent. Yarding with a rubber-tired skidder, had the greatest amount of detrimental soil disturbance. McIver (1998) also found that mechanized cut-to-length harvesters tended to result in displacement, rather than compaction, as the primary form of detrimental soil disturbance.

While displacement can be the primary issue with harvesters and forwarders, it is not the only way they can cause detrimental soil disturbance. Harvester and forwarders can limit their soil disturbance by using slash as a buffer to the weight of the equipment. This is true even though they have a shorter reach than most other yarding systems and they create more trails. However, there are conditions when this equipment’s ability to use slash (buffering equipment weight) is limited. In stands with low stocking or a light harvest (low slash available) to buffer equipment weight; needed amounts of slash may not be present.

Another condition that is not conducive to a forwarder for low soil impacts is salvage of wildfire-burned or dead trees. The buffering effect of slash used by forwarders is due to the springing nature of fresh slash, under the weight of the equipment. Fire killed trees or dead trees typically do not have slash to hold the weight of the forwarder. Plus, the forwarder must make more passes due to its shorter reach. Therefore, it is very likely forwarders will have an increased soil disturbance in a salvage situation.

Skyline logging with one end or full suspension can result in very little soil disturbance. Allen et al. (1999) found that using a cut-to-length harvester and skidding operation for partial cuttings in western and northeastern Oregon resulted in detrimental soil compaction on 21 percent of the area. Skyline yarding resulted in detrimental soil disturbance (compaction and displacement) on about 6 to 7 percent of the harvested area. Results indicated that skyline yarding created more displacement than compaction. After one year, Allen et al. (1999) found that there was no off-unit sediment transport from these areas, with the exception of very limited amounts from skyline corridors.

McIver et al. (2003) found that uneven-aged and intermediate treatment activities using a cut-to-length forwarder system resulted in detrimental soil conditions in no more than eight percent of an activity area.

Craigg and Howes (2007) found that a thinning project using a low ground-pressure Timberjack cut-to-length harvester and forwarder and a variety of mitigation measures designed to reduce soil impacts, including, operating on frozen ground, snow and slash, designated trail spacing, and hand piling of slash, resulted in detrimental soil conditions on approximately three percent of the activity area.

Bliss (2006) assessed several published and non-published detrimental soil conditions surveys for the Wallow-Whitman National Forest and compiled a summary of findings. Adjustments in treatment made after the 1990 Forest Plan was implemented resulted in a reduction in detrimental impacts to soils. In general, post-harvest ground disturbance ranged from approximately 10 to 20 percent, with a range of 6 to 12 percent of new detrimental soil conditions. The amount of new disturbance was found to vary depending on the amount of new skid trails created and used.

Table 136 displays the range (in acres) of detrimental soil conditions on the landscape as a result of historic timber harvest activities. The range (in acres) of detrimental soil conditions from ground-based timber harvest activities was determined by calculating 5 percent and 55 percent of the acres of timber harvest, the lowest published detrimental soil conditions (Craigg and Howes 2007) and the highest published detrimental soil conditions (Miller et al. 2010) respectively. Five percent was added to the result to account for detrimental impacts from constructing system roads and temporary roads.

The range (in acres) of detrimental soil conditions on the landscape as a result of historic aerial timber harvest activities was determined by calculating 2 percent and 6 percent of the acres of aerial timber harvest, the lowest published detrimental soil conditions (Allen and Adams 1997) and the highest published detrimental soil conditions (Bliss 2006) respectively. Again, five percent was added to the result to account for detrimental impacts from constructing system roads and temporary roads.

Table 136. Estimated acres of detrimental soil conditions (DSCs) for ground-based and cable and aerial logging systems for each National Forest

National Forest	Ground-based Timber Harvest Activities		Cable and Aerial Timber Harvest Activities		Total Timber Harvest Activities	
	Harvest	Range of DSCs	Harvest	Range of DSCs	Harvest	Range of DSCs
Malheur	407,486	40,748 to 244,491	49,347	3,454 to 5,428	456,833	44,202 to 249,919
Umatilla	185,936	18,593 to 111,561	64,654	4,525 to 7,111	250,590	23,118 to 118,672
Wallowa-Whitman	300,676	30,067 to 180,405	24,846	1,739 to 2,733	325,522	31,806 to 183,138
Totals	894,098	89,408 to 536,457	138,847	9,718 to 15,272	1,032,945	99,126 to 551,729

The ranges (in acres) of detrimental soil conditions for both ground-based and aerial harvest systems include impacts associated with site preparation activities and post-harvest treatments, such as slash treatment. The acres of past timber harvest activities were calculated using GIS data. Since some areas have been harvested more than once, acres for these areas are included more than once in the totals displayed in Table 136.

Ground-based timber activities have generally been implemented on slopes with less than 30 percent rise. In some cases, ground-based harvesting may have occurred on slopes with greater than 30 percent rise, but since the late 1990s typically these situations are limited to more than 100 feet. So impacts arising from ground based equipment on slopes steeper than 30 percent tend to be localized and easier to mitigate or of minimal consequence. Sky line or aerial timber activities have generally been implemented on slopes with greater than 30 percent rise and in some areas where protection of soils and other resources is a priority (such as post-wildfire salvage operations).

Wildland and Prescribed Fire

Wildland fires are a natural ecological process within the forests of the Blue Mountains. “Both wildfire and prescribed fire can drastically alter soils and the services they provide” (Erickson 2008). The range of effects describing wildfire can begin with a description of restorative, move to benign, and end with a determination of detrimental (Erickson 2008).

High intensity fire and severe burns over large portions of landscapes can occur, which can cause an array of ecosystem responses (Keeley 2009). Commonly, it is high-intensity fire that is

associated with the detrimental range of effects. Understanding the effects of fire throughout the planning area is difficult. The variation in natural potential vegetation and natural historic fire regime include community composition and structure, fuel composition and quantity, climate, soil properties, topography, the long period of fire exclusion since Euro-American settlement, fire suppression, post fire restoration, and post fire timber salvage activities. The extent, intensity, or "soil" burn severity, and resulting impacts have varied widely. An increase in wildland fire size and quantity has been documented since the early 1960s, with greater increases documented starting in the 1980s. Greater increases in wildfire ignitions and severity have been documented in the 2000s.

Wildland fires or prescribed fires characteristic of the historic fire regime with low or moderate burn severities can improve soil fertility by facilitating periodic release of nutrients (Smith et al. 2017). High intensity fire however can have substantial impacts on ecosystem processes. It is commonly assumed these impacts are due to the total consumption of the forest floor and the loss of coarse woody debris. It is the coarse woody debris that serves as a nutrient reserve for storage of forest nutrients necessary for sustaining plant growth, biological activity (Harvey et al. 1987 and Smith et al. 2017), and slowing soil erosion, especially on steep slopes.

Loss of the forest floor's effective ground cover and coarse woody debris has been related to an increase in sheet, rill, and gully erosion and reduced infiltration rates leading to increased rates of erosion, sedimentation and flooding (Robichaud and Brown 1999). The predominant process is the reduction in canopy cover, but more importantly the loss of effective ground cover, and the subsequent increase in mineral soil exposed to raindrop splash and surface sealing. Increased erosion as a result of burning is also influenced by fire intensity and burn severity. Other factors for increased erosion include creation of water repellant soil (hydrophobic) and the resultant increased runoff and overland flow. Coarse textured soils are more prone to becoming hydrophobic following a wildfire than fine textured soils. Reports show hydrophobic compounds can be relatively short lived, and are broken up or washed away after a winter of slow wetting and freeze-thaw (MacDonald and Huffman 2004). A report offers that "water repellency weakens with each rainfall and does not persist for longer than two to four years after a burn" (Berkley 2015).

National Forest lands where wildfires (unintended) exceed 500 acres are subject to a Burn Area Emergency Response assessment. This assessment will evaluate the effects of the wildfire to federally managed lands and exclude the effects of the suppression activities from fire fighters. Due to the quick assessment time, they can offer insight to fire intensity and burn severity; but they should not be considered a comprehensive wildfire examination.

Since about 2000, surveys have been conducted within the Wallowa-Whitman National Forest to estimate the amount of coarse woody debris following fires and salvage activities. These surveys indicated that the units generally meet or exceed the minimum recommended amounts of coarse woody debris. Recruitment of fine organic debris from needle cast and limbs both post fire and after salvage activities has contributed to sustaining the long-term nutrient stores throughout the planning area (Graham et al. 1994).

Salvage logging following wildfires was identified as a cause of erosion affecting stream sedimentation and productivity in the interior western U.S. (Wagenbrenner et al. 2014). Published studies reported that the implementation of resource standards and guidelines for site protection at salvage logging sites within the salvage area (Wagenbrenner et al. 2014) were the most important factors that influenced a reduction in soil erosion. In addition, ground-based yarding systems

resulted in far more soil disturbance than aerial systems in salvage operations (Wagenbrenner et al. 2014, McIver and McNeil 2006).

Assessing or quantifying soil conditions after wildland fire and prescribed fire is difficult due to the many variables affecting ecosystem response to fire. In a 2004 report, the average percent of high and moderate severity class throughout the nation tends to range from 39 percent of the burn area (Eidenshink et al. 2007).

The overall effect of wildland and prescribed fire on above-ground organic matter (dead and down material) and subsequent soil fertility, soil carbon, and nitrogen changes are difficult to quantify on a landscape scale (Johnson and Curtis 2001). In an extensive literature review of forest management effects (including fire) on soil carbon and nitrogen, Johnson and Curtis (2001) found that the effects of fire on soil carbon and nitrogen are quite variable and difficult to quantify. They also found the amount of time after a fire event to be an important consideration, with an increase (compared to study plots) in both soil carbon and nitrogen documented after approximately 10 years. In addition, they documented decreases in soil carbon following prescribed fire and increases in soil carbon and nitrogen following wildfire. The increases following wildfire was attributed to the sequestration of charcoal and recalcitrant and hydrophobic organic matter.

Fire suppression activities (such as fireline and fuel break construction and construction of fire camps and aircraft landing zones) tend to compact or displace surface soil and have had indirect impacts on long-term soil productivity and hydrologic function throughout the Plan Area. It is assumed that within the Plan Area, high wildland fire severity and fire suppression have caused an array of ecosystem responses, including vegetation changes, increased erosion, and reduced organic materials and coarse woody debris amounts to less than the optimum levels needed to sustain soil productivity and soil health (Page-Dumroese et al. 1997)

Livestock Grazing

Commercial livestock grazing began in the late 1800s with Euro-American settlement. From the late-1800s to mid-1900s, livestock grazing management was very limited and generally involved continuous, year-round grazing. As a result, much of grazing lands in the Blue Mountains national forests were severely impacted by overgrazing. These impacts are still evident on the landscape (Averett 2014). Soil disturbances caused by historic overgrazing generally consist of compaction, displacement, alteration of vegetation community (ground cover diversity and composition), and invasion by non-native species.

Soil disturbance and the degree of impact from livestock grazing activities throughout the Plan Area is variable. It has been influenced by many factors, including the type and intensity of historic and current livestock grazing (season of use, livestock use patterns, density of livestock, degree of disturbance, and type of livestock: cattle, sheep, horses, or goats), soil type (soil depth and volcanic ash content), compaction or displacement potential of the soil, slope gradient, aspect, and other inherent and dynamic properties.

Capable grazing lands for sheep are associated with landtype associations with slopes of less than 60 percent, and slopes with less than 45 percent rise are considered capable for cattle grazing. Capable grazing lands also have a tree canopy and/or unpalatable shrub canopy of less than 60 percent and/or have the inherent capacity to produce more than 200 pounds of forage per acre. Production of forage can be limited by amounts of rock outcrops or nutrient poor or shallow soils.

Sites associated with landtype associations determined to have poor capacity for grazing (i.e., greater than 40 percent slope rise for cattle, greater than 60 percent slope rise for sheep, and low forage production rates) are considered to have less resistance and decreased resiliency to grazing effects on the soil and vegetation components (Sasich 2006). However, due to the severity of topographic features, including steepness of terrain and high amount of rock outcrops limiting access to slopes with greater than 60 percent rise, these areas are generally grazed incidentally and used lightly and are assumed to have little to no measurable detrimental soil impacts associated with livestock grazing and management.

Existing Soil Conditions at Roads and Landings

Roads and landings are considered part of the permanent national forest management infrastructure and transportation system and are estimated to be 5 percent of the managed acres within a national forest. These acres are considered to be in a permanent detrimental soil condition. Even if some road segments are decommissioned and restored; the site conditions of depth and inherent soil organic matter with the road effects, relative to soil productivity may result in localized irretrievable loss.

Soils – Environmental Consequences

Management activities can result in direct and indirect effects on soil resources, which may include alterations to physical, chemical, and/or biological properties. Soil disturbance is defined as any Forest Service management practice that results in soil compaction, puddling, displacement, severe burning, or the loss of ground cover (USDA 1990). Puddling, severe burning, and loss of ground cover are not very common, while compaction (increase in soil bulk density with a decrease in soil porosity) and displacement are common effects of management activities that can negatively affect soil productivity. Indirect effects may include erosion, mass wasting, changes in water table, soil biology, organic detritus recruitment, and fertility, such as the fertilization effects of ash after a low intensity fire.

This “Soils” section of the Draft Environmental Impact Statement is not a spatial analysis of effects on soils. A forest plan is a programmatic document and no specific management actions are proposed. Each alternative would comply with laws, regulations, and policies in place to ensure maintaining soil quality and meeting minimum soil productivity standards. Additionally, the maintenance of soil function is a critical component of the objectives and desired conditions developed for each of the alternatives for forest plan revision.

Soil management on National Forest System lands often centers around soil disturbance. The current Forest Plans place a disturbance cap on management activities in order to maintain the productivity of the land. The effort was continued with the Forest Service Manual Chapter 2520 Region 6 Supplement, which placed a detrimental soil disturbance cap of 20 percent on management activities excluding established transportation infrastructure.

Detrimental soil disturbance is defined as disturbances, including the effects of compaction, displacement, rutting, severe burning, surface erosion, loss of surface organic matter, and soil mass movement that indicate when changes in soil properties and soil conditions would result in significant change or impairment of soil quality.

All alternatives are in compliance with soil management direction in Forest Service Manual 2550 Soil Management along with any amendments and regional supplements.

Effects Common to All Alternatives

Regardless of alternative, the standards and guidelines mentioned in this document are to be used for the protection of soils and to attain the desired condition for the soil resource. The following desired condition is proposed for all alternatives:

> The productive potential of forest and range soils is maintained at levels that contribute to long-term sustainability of ecosystems considering the range of possible climate change scenarios. Soil physical and chemical properties (texture, porosity, strength, coarse fragment content, and fertility) and organic matter (surface woody debris, humus) are at levels that maintain soil productive potential and hydrologic function (infiltration, percolation, and runoff). Surface soil erosion and sediment deposition rates are within the natural range of variability for each biophysical setting.

Upon implementation, each alternative would lead to a unique combination of activities designed to meet land management objectives (design criteria). The indicator used to analyze environmental consequences to soils is the potential acres of detrimental soil conditions associated with proposed acres of ground-disturbing activities.

Timber Harvest, Wildland Fire, and Fuels Reductions

Disturbance to forest soils can result from the use of heavy equipment during timber harvest operations, including harvesting, yarding, sorting at landings, site preparation, slash treatment, and restoration activities.

Soil disturbance caused by logging can have detrimental or negative effects on soil quality and site productivity (Froehlich 1981). The intent of forest plan standards and guidelines is to minimize the extent (area) of detrimental levels of soil disturbance. Specifically, the total area exceeding criteria for detrimental disturbance in any harvest unit should be no more than 20 percent.

Table 137 through Table 139 display the projected annual acres of timber harvest and fuels reduction treatments that have the potential to impact soils for each alternative for each national forest.

Table 137. Acres of proposed ground-disturbing activities with timber harvest and fuels reduction by alternative on the Malheur National Forest

Activity	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Even-aged regeneration harvest (ground-based system)	133	1,335	712	2,937	2,581	1,112	1,112	1,602
Even-aged regeneration harvest (cable system)	17	165	88	363	319	138	138	198
Uneven-aged and intermediate harvest	6,950	5,600	2,600	17,200	9,600	11,250	18,450	6,500
Timber harvest totals	**7,100**	**7,100**	**3,400**	**20,500**	**12,500**	**12,500**	**19,700**	**8,300**
Planting	100	700	400	1,600	1,400	900	900	900
Non-commercial thinning	1,400	1,400	1,000	3,000	1,400	1,600	1,600	1,400
Burning and mechanical treatment of fuels *	16,600	16,600	12,900	20,500	22,000	22,000	29,200	17,800

* Mechanical treatment of fuels (mastication) is expected on more than 25 percent of the acres listed.

Table 138. Acres of proposed ground-disturbing activities with timber harvest and fuels reduction by alternative on the Umatilla National Forest

Activity	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Even-aged regeneration harvest (ground-based system)	231	1,068	445	2,314	1,513	1,112	1,112	1,335
Even-aged regeneration harvest (cable system)	29	132	55	286	187	138	138	165
Uneven-aged and intermediate harvest	4,940	4,000	1,800	13,000	5,700	6,150	13,050	4,900
Timber harvest totals	5,200	5,200	2,300	15,600	7,400	7,400	14,300	6,400
Planting	150	600	200	1,300	1,200	1,000	1,000	700
Noncommercial thinning	1,600	1,600	1,500	3,200	1,600	1,400	1,000	1,600
Burning and mechanical treatment of fuels *	15,200	15,200	12,300	16,000	17,400	17,400	24,300	16,400

* Mechanical treatment of fuels (mastication) is expected on more than 25 percent of the acres listed.

Table 139. Acres of proposed ground-disturbing activities with timber harvest and fuels reduction by alternative on the Wallowa-Whitman National Forest

Activity	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Even-aged regeneration harvest (ground-based system)	80	890	445	2,225	1,780	1,335	1,335	1,246
Even-aged regeneration harvest (cable system)	10	110	55	275	220	165	165	154
Uneven-aged and intermediate harvest	4,410	3,550	1,550	13,750	7,350	7,800	15,000	4,650
Timber harvest totals	4,500	4,550	2,050	16,250	9,350	9,300	16,500	6,050
Planting	50	500	200	1,200	1,000	1,200	1,200	700
Non-commercial thinning	2,600	2,600	1,700	5,200	2,600	1,600	1,600	2,600
Burning and mechanical treatment of fuels *	15,000	15,050	12,550	17,000	19,850	19,800	27,000	16,550

* Mechanical treatment of fuels (mastication) is expected on more than 25 percent of the acres listed.

Even-aged Regeneration Harvest

Even-aged regeneration harvest can include clearcut with reserve trees, shelterwood, and seed tree prescriptions. These harvest activities are generally followed by additional activities (fuels reductions or subsoiling) and may include tree planting. Even-aged regeneration harvest and yarding can be accomplished using either ground-based logging equipment, cable/aerial logging systems, or a combination of both. Ground-based equipment is generally limited to slopes with less than 30 percent rise (USDA Forest Service 1990). From time to time this limit is exempt, where short distances (less than 100 feet) may exceed 30 percent. The common scenario is when two flat harvest areas can easily be accessed by skid trail over a short distance, rather than creating another access point with an additional temporary road. A cable logging system is generally used on slopes with greater than 30 percent rise or on sites where protection of soils or other resources is a priority (such as post-fire harvest).

For analysis purposes, even-aged management activities using ground-based equipment are assumed to result in approximately 10 to 20 percent ground displacement and disturbed soils and no more than 15 percent of the area in new detrimental soil conditions for any unit. The majority of new detrimental soil conditions are assumed to be soil compaction and loss of effective ground cover.

Even-aged management activities using a cable logging system are assumed to result in no more than 6 percent of the area in new detrimental soil conditions for any logging unit. These estimates are based upon cable activities being able to attain at least one end suspension. The majority of detrimental soil conditions with cable systems are assumed to be soil displacement (Han 2007, Han 2006, Drews et al. 2001, McIver and Starr 2001). These estimates for ground-based and cable logging systems take into account disturbances from other associated timber harvest activities, including landings and fuels reductions. Landings are estimated to account for approximately 1 to 2 percent of detrimental soil conditions in a harvest unit area, and fuels reductions activities are estimated to account for approximately 1 to 4 percent of detrimental soil conditions (Farren 2006 and 2006b). Detrimental soil conditions associated with roads are not included in new disturbances due to Forest Service direction to use existing system roads and to minimize any new road construction. Provided implementation follows usual recommended implementation design criteria, detrimental soil condition values are assumed to be valid.

Uneven-aged and Intermediate Harvest

Uneven-aged and intermediate harvest currently generally consists of single-tree selection, small group selection, and intermediate thinning activities designed to maintain or enhance uneven-aged stand structure and reduce fire risk. These harvest activities are generally implemented using ground-based equipment. Magnitude, extent, and duration of effects on soils are expected to be considerably less than those expected for even-aged harvest. This is mainly due to the ability to use smaller, lighter equipment and harvest less volume of material, which, when yarded, results in fewer equipment passes.

Based on recent monitoring and research results, uneven-aged and intermediate treatment activities using ground-based equipment can be expected to result in no more than 8 percent of the area in new detrimental soil conditions (McIver et al. 2003, Craigg and Howes 2007). The majority of new detrimental soil conditions is expected to be soil compaction and loss of effective ground cover. This estimate takes into account new detrimental soil conditions from associated landings and post treatment fuel reduction activities (Farren 2006). Uneven-aged and intermediate harvest can result in more stand entries than even-aged harvest treatments. Detrimental soil conditions associated with roads are not included in new disturbances due to Forest Service direction to use existing system roads and to minimize new road construction. Compaction can be limited on some dense soils by logging under dry soil conditions. Loss of effective ground cover can be limited by utilizing logging slash as ground cover at the close of activates. Provided implementation follows usual recommended design criteria, detrimental soil condition values should be valid. Detrimental soil conditions associated with roads are not included in new disturbances due to Forest Service direction to use existing system roads and to minimize new road construction.

Noncommercial thinning and mechanical fuels treatment activities may be accomplished by hand or with ground-based mechanical thinning equipment and/or grapple-piling equipment depending upon site-specific design criteria, desired condition, and other resource objectives. Fuels treatments may include some combination of thinning and piling, thinning slash by hand or

machine, burning or chipping, broadcast prescribed burning, mechanical crushing of fuels, or removal of small diameter biomass for commercial use. Though not currently practiced in the Blue Mountains, if biomass is collected from above and below ground, known as complete tree harvesting (crown, bole and tree roots); effects are yet to be fully evaluated. It is assumed the level of disturbance from complete tree harvest would be detrimental, from both the visual disturbance and loss of organic matter that may buffer soil nutrients and moisture in the soil. Given the societal values for more intensive harvesting and because complete-tree harvesting requires additional operations and processes, common biomass harvesting in the Blue Mountains range is likely to remain whole-tree harvesting (Jang et al. 2015). Due to the growing commercial value of biomass for fuel, the removal of small diameter logs from the treatment unit is more likely than in the recent past. While collection and harvest of surface material has an effect, when those effects are compared to natural disturbance, biomass harvest rates fall in the middle of possible disturbance scenarios in the forest. Detrimental impacts among the disturbance agents can be seen as follows: debris avalanches are greater than fire, which is greater than biomass harvesting, which is greater than wind throw and insect/pest attack (Jang et al. 2015). It is assumed that biomass harvest is rated higher than wind throw because roots remain intact following activities. Note that adverse consequences depend on the intensity of disturbances, and site conditions (resilience) can substantially ameliorate or aggravate the negative impacts (Jang et al. 2015). These effects may be seen on a smaller scale from tree tipping for in-stream fish structures.

For mechanical crushing of fuels, grapple or mastication; equipment heads are mounted on small-body excavators with wide tracks similar to those used with mechanical harvesters. These machines have relatively low ground pressure and can work on top of downed logs and existing or thinning-created slash. However, this equipment has been found to produce additional compaction on operation trails and some soil displacement while turning (Farren 2006, and Bliss 2006). In some cases when small body excavators are used and soil moisture is elevated, they can still cause excessive soil damage with compaction, due to soil moisture reducing bearing strength of the soil. An examination of unpublished monitoring in the Loon Timber Sale (Umatilla National Forest), saw a small machine (spring piling operation) that resulted in more than 20 percent detrimental soil conditions. In a neighboring harvest unit, harvested concurrently but not piled, the same monitoring determined no exceedance in detrimental soil conditions. Therefore, it is assumed the detrimental soil conditions exceedance occurred because of elevated moisture conditions during piling, not from harvest impacts. It is assumed the detrimental soil conditions were caused by the equipment movement being on freshly exposed moist soil; rather than the excess slash which can serve as a weight buffer over moist soil.

Precommercial thinning and mechanical fuels treatment activities using ground-based equipment can be expected to result in no more than approximately 5 percent of an activity area in new detrimental soil conditions; provided these treatments follow needed implementation design criteria. This estimate takes into account new detrimental soil conditions associated with post-thinning fuels treatments and associated landings from biomass removal (Farren 2006). Detrimental soil disturbance is commonly well distributed across activity areas, and ground cover is generally minimally disturbed. Detrimental soil conditions associated with roads are not included in new disturbances due to Forest Service direction to use existing system roads and to minimize new road construction. Provided implementation follows usual recommended design criteria, detrimental soil condition values are assumed to be valid.

Activities with Few or No Predicted Negative Effects on Soils

Some activities generate few, if any, measurable detrimental effects on soils. Planting of vegetation is typically accomplished using hand-held tools and bare root or containerized seedlings. Planting can be a factor in surface displacement, but it is expected to be minimal and of such a short duration; its effects are not expected to be measureable. Generally, there is little or no detrimental soil disturbance associated with this activity, with the exception of preparing the actual planting sites with hand tools in order to achieve better seedling establishment. Overall, the planting of live vegetation helps to build soil organic matter which will improve soil health, so this activity can be an assumed to benefit the soil resource. Knowledge of the soils present at planting sites, seasonal and diurnal temperature and moisture fluctuations, soil moisture release characteristics, and coarse fragment content are all important factors considered when preparing for successful planting projects. This is especially true where overstocked droughty soils may not be currently managed at sustainable plant densities.

Precommercial thinning by hand (personnel using chainsaws or other equipment) generates little or no measurable soil disturbance. Thinning slash, whether left in place or hand-piled, remains largely within the unit. Burning, if prescribed, often occurs one to three years after thinning, which allows needles to fall from branches and reduce fire risk to residual trees. Piles are normally small and fire intensity from pile burning rarely produces severe soil burn effects. Detrimental soil conditions resulting from burning of hand piled fuels is estimated to be no greater than 1 percent of a treatment area (Bliss 2006).

Prescribed fire can release nitrogen into the soil, initially increasing productivity in both the short term and long term (Raison 2008). The long-term decreases in soil productivity from nutrient losses are determined by how often and how severely the soil is disturbed. Soil productivity can increase where low-severity fires take place periodically and nutrients tied up in understory vegetation and woody debris become available for residual plant uptake (Oliver and Larson 1996). Burning can also favor fire-resistant plants, such as grasses, and some pioneering plants, while fire killed plants may provide a significant source of nutrients to the soil (Chen and Hicks 2002).

Prescribed burning following harvest activities may create some areas of high-severity burn where fuels are concentrated and burn for a long time (residence time). Severe burn areas are typically associated with pockets of concentrated post-harvest fuel loads and areas adjacent to and under logs and stumps. Past monitoring of prescribed fire areas revealed that prescribed underburning produced severe burn soil effects on less than 4 percent of an area (Bliss 2001, Farren 2006). However, severe burn effects from prescribed fire rarely if ever impact more than 100 square feet (USDA Forest Service 1990). Nevertheless, areas of severe soil burning are associated with decreased effective ground cover and soil surface organic matter important for water retention, soil structure, nutrient cycling, and microbial populations (Powers et al. 1980). Severe burning of soils has been associated with decreased infiltration, increased runoff, and accelerated erosion. The erosion risk may or may not be realized after prescribed burning activities depending upon the extent of severely burned soils and upon weather events. The amount of severely burned soils and ground cover reduction from prescribed burning is proportional to the acres treated by underburning.

Noxious weed suppression or eradicating populations of invasive plants is typically an activity that generates few if any soil disturbance concerns. From time to time eliminating noxious weeds (herbicides or fire) will denude a site of vegetation, but such cases should be concurrently scheduled for replanting or reseeding; with a desired mixture of plant species, at an acceptable

effective ground cover. Most weed suppression is accomplished by hand pulling and grubbing or by applications of approved herbicides by hand or from an all-terrain vehicle or truck bed. Hand grubbing can create some localized soil disturbance; however, its degree and extent is usually of no concern from a soil productivity or erosion standpoint. When planning a weed control project, knowledge of soil characteristics, such as organic matter content and texture, is important in order to meet label requirements for certain herbicides. On all three National Forests, an Invasive Plants Treatment Record of Decision limits chemicals to be used and relegates use to areas where those chemicals are not influenced by water, soil texture and soil depth. Existing direction calls for site specific analysis where proximity to water and soil characteristics such as texture and depth are taken into consideration when choosing the appropriate herbicide to use. When new areas are proposed, moisture and soil limits are identified. Those areas with an environmental limit are either excluded from herbicide or have the use of certain herbicides limited on the basis of water, soil moisture, soil texture and or soil depth.

While noxious weed reduction activities may create some amount of soil disturbance, it is anticipated that there will be few, if any, measurable adverse impacts. With the assumed return of desired vegetation; there is an assumption that soil health will improve. Some alternatives would have more acres of disturbance activities than others; however, it would be impossible to quantify the impacts on soils and future productive potential and thus determine that any one alternative would create more detrimental soil impacts than another. Therefore, these activities will not be considered further in the analysis of soil impacts.

Discussion of Risk for Activities that Generate Effects on Soils

Fundamental to sustainable use of National Forest System lands is the ability to assess relative risk, or lack thereof, of a proposed activity at a specified location and time (Reynolds et al. 2011). A risk strategy recognizes potential risks of a given action or inaction. By assessing the relative risk of incurring soil damage, an activity that best fits site-specific conditions can be prescribed and implemented. Complexity of interactions among activities, local conditions, and on- and off-site consequences must be recognized. Following is a brief description of the analysis procedure and calculations used to estimate change in detrimental soil conditions by alternative.

In evaluating the potential effects of the alternatives on soils, a comparison of the total acres that would be treated for each activity is used as a surrogate for potential detrimental soil effects. To estimate the amount of detrimental soil conditions resulting from those activities during the life of the plan, the number of acres of potential detrimental soil condition is calculated using the following formula:

Annual basis = acres of activity x by percent soil disturbance factor of specific treatment

Acres of activity by national forest and alternative on an annual basis are displayed in Table 140 through Table 142.

Table 140. Acres of detrimental soil conditions associated with timber harvest and fuels reduction treatments expected annually on the Malheur National Forest

Activity	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Even-aged regeneration harvest (ground-based)	20	200	107	441	387	167	167	240
Even-aged regeneration harvest (cable)	1	10	5	22	19	8	8	12
Uneven-aged and intermediate harvest	556	448	208	1,376	768	900	1,476	520
Precommercial thinning	0	70	50	150	70	80	80	70
Mechanical treatment of fuels*	90	90	45	770	155	155	245	105
Total estimated acres of detrimental soil conditions	**737**	**818**	**415**	**2,738**	**1,399**	**1,310**	**1,976**	**947**

* The actual amount of detrimental soil conditions may vary as a result of equipment in mechanical fuel treatments. Detrimental soil conditions from actual burning, would likely be inconsequential or not measurable, especially if mixed severity burns occur.

Table 141. Acres of detrimental soil conditions associated with timber harvest and fuels reduction treatments expected annually on the Umatilla National Forest

Activity	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Even-aged regeneration harvest (ground-based)	35	160	67	347	227	167	167	200
Even-aged regeneration harvest (cable)	2	8	3	17	11	8	8	10
Uneven-aged and intermediate harvest	395	320	144	1,040	456	492	1,044	392
Noncommercial thinning	80	80	75	160	80	70	70	80
Mechanical treatment of fuels*	65	65	30	65	93	93	180	80
Total estimated acres of detrimental soil conditions	**577**	**633**	**319**	**1,624**	**867**	**830**	**1,469**	**762**

* The actual amount of detrimental soil conditions may vary as a result of equipment in mechanical fuel treatments. Detrimental soil conditions from actual burning, would likely be inconsequential or not measurable, especially if mixed severity burns occur.

Table 142. Acres of detrimental soil conditions associated with timber harvest and fuels reduction treatments expected annually on the Wallowa-Whitman National Forest

Activity	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Even-aged regeneration harvest (ground-based)	12	134	67	334	267	200	200	187
Even-aged regeneration harvest (cable)	1	7	3	17	13	10	10	9
Uneven-aged and intermediate harvest	353	284	124	1,100	588	624	1,200	372
Noncommercial thinning	130	130	85	260	130	80	80	130
Mechanical treatment of fuels*	55	55	25	635	115	116	206	75
Total estimated acres of detrimental soil conditions	**674**	**609**	**304**	**2,345**	**1,113**	**1,030**	**1,696**	**773**

* The actual amount of detrimental soil conditions may vary as a result of equipment in mechanical fuel treatments. Detrimental soil conditions from actual burning, would likely be inconsequential or not measurable, especially if mixed severity burns occur.

The estimated amount of detrimental soil conditions is calculated assuming approximately 90 percent of the even-aged harvest treatment acres would be harvested using a ground-based logging system and the remainder (approximately 10 percent) with a cable logging system. Acres that would be treated are assumed to be equally distributed across MA 4A General Forest but not equally distributed across potential vegetation groups. It is estimated that 60 to 90 percent of the timber harvest activities will take place within dry forest potential vegetation groups.

Approximately 5 to 10 percent and 10 to 30 percent would occur within the cold forest and moist forest potential vegetation groups, respectively (Table 143). However, acres to be treated would be determined on a site-specific basis, taking into account the need for the project and the condition of the area to be treated.

Table 143. Distribution of timber management activities between potential vegetation groups

Potential Vegetation Group	Distribution of Timber Management Activities
Cold forest (associated with ash cap soils)	5-10%
Moist forest (associate with ash cap soils)	10-30%
Dry forest (associated with low ash content soils)	60-90%

All alternatives would result in some degree and extent of detrimental soil conditions. Provided they are implemented with all required best management practices and site-specific design criteria; each alternative should comply with the laws, regulations, and policies to ensure maintaining soil quality and at least meeting minimum soil productivity standards.

Actual impacts of each alternative on soil productivity and hydrologic properties would be evaluated at the project level and would be dependent on local soil characteristics, equipment used, time of operation, and other resource values.

In summary, the acres of new detrimental soil conditions anticipated from implementation of the alternatives are based on best available science and is calculated using recent local monitoring data. Timber management activities with contemporary harvest systems (such as fuels reduction activities and timber harvest) can generally meet minimal detrimental soil condition standards. However, that actual amount of new detrimental soil disturbance would vary by soil moisture during activities, degree, extent, duration, and distribution or pattern depending on highly variable soil and site characteristics (Jurgensen et al. 1997) and on site-specific project design. In many instances, less detrimental soil disturbance would be achieved through use of state-of-the-art timber harvesting and processing equipment and other design criteria, such as avoidance of unsuitable or high-risk areas. Additionally the prevention of logging on soils not dry enough to carry equipment without rutting will help to limit detrimental soil conditions. Furthermore, rehabilitation work before final completion of operations can further reduce impacts from timber harvest activities and related long-term effects to soils.

An indication of the relative magnitude of effects of activities on soil productivity between alternatives can be obtained by comparing acres of treatment occurring in different forest types (dry, moist, and cold potential vegetation groups), along with differences in inherent soil productivity and operability limitations.

When activities occur in areas with low inherent soil productivity (such as dry, shallow, and rocky soils) or and severe limitations to operability of ground-based equipment (such as thick ash-capped soils with high risk of compaction), it is likely that potential soil impacts will be greater without site-specific design criteria to offset the extent, degree, and duration of soil impacts. Design criteria implementation measures may include, but will not be limited to:

- Use of existing skid trails to avoid increasing detrimental soil conditions
- Wide spacing between trails for shallow rocky soils, to limit new detrimental soil conditions
- Winter logging with a base of frozen ground to limit detrimental soil conditions
- Implementation of restoration activities to eliminate old or new detrimental soil conditions:
    - Subsoiling to reduce soil density and increase water infiltration
    - Placement of effective ground cover to limit erosion and sediment

Site-specific inherent properties and limitations would be considered when developing specific project objectives and design features. Even though the potential for adverse effects on soils may be high, actual measured effects may be lower than expected and within an acceptable range if the project is carefully designed and implemented. Factors for the anticipated impacts (winter logging), and combined effects (weather and road conditions) are considered during project-specific analysis such that appropriate mitigations can be implemented (for example, specifying seasonal restrictions for construction or harvests to minimize the break-up of asphalt or serious damage to aggregates and using slash to protect native surfaced roads).

Roads

Road construction and reconstruction can have large and long-lasting effects on soils and watersheds. Roads can intercept and reroute subsurface water movement down slope, which can lead to upslope and cutbank failures and sediment deposition into drainage channels, culverts, and water sources. Roads intercept rainfall and channel it onto hill slopes or ditchlines; accelerating water movement and loss from the area. Road cutbanks are subject to rill erosion if not properly constructed and stabilized

Roads also remove areas from the productive land base. From a soil productivity standpoint, they are completely non-productive. Roads that are components of the permanent transportation system are not considered a soil productivity concern unless they are to be returned to the productive land base. In some cases, shallow soils where a road was obliterated may lag in recovery of soil productivity.

Disturbance caused by road construction activities can also reduce soil productivity and hydrologic function and can make up large percentages of activity areas (i.e., temporary roads) and watersheds (i.e., permanent roads). Analysis of environmental consequences of timber harvest activities on soils includes the assumption that approximately 5 percent of an activity area is comprised of detrimental soil conditions associated with permanent and temporary roads.

Road construction and maintenance effects are assumed greatest in landtype associations with steep and/or unstable slopes and highly erodible soils. Landtype associations have been evaluated for their suitability for road construction and the limitations they present. Road effect risk ratings from low to high have been assigned for each landtype association (more information is available in the planning record). Given the scale of mapping for landtype associations, some areas of difficult road construction and high potential for detrimental soil effects may be encountered in landtype associations with low risk ratings. In areas with Terrestrial Ecosystem Unit Inventory mapping finer detail soils information will be available for planning and implementation. Effects of trail construction, motorized, nonmotorized, and off-road vehicle use can be evaluated using the same factors.

Livestock Grazing

Like timber management activities, livestock grazing (as well as concentrations of herbivorous wildlife species) can have substantial and detrimental effects on soils. Visual impacts of timber management activities on the soil resource can range from short-term (easily observable or detectable) to long-term cumulative impacts (subtle). Grazing impacts on soils; like the cumulative impacts from timber sale activities can be subtle and go unnoticed unless non-impacted areas are available for comparison or repeated observations are made over time. However, there are exceptions, such as stock watering sites, salting stations, and livestock holding facilities, where impacts may be obvious.

The process for assigning risk classes for grazing included determining the overlap of landtype associations with grazing suitability acres for each alternative, the acres assigned as suitable are seen in Table 144. Each grazing suitability class was assigned a rating of low, moderate, or high. As described previously, livestock grazing impacts to soils are considered as part of the grazing suitability analysis and determination (refer to the “Livestock Grazing and Rangeland Vegetation” section in this chapter). All alternatives include the continuation of permitted livestock grazing. The number of acres suitable for grazing is displayed in the Table 144. Unsuitable grazing lands generally included landtype associations with steep slopes, very shallow and rocky soils, and sites producing less than 200 pounds of forage annually.

Table 144. Permitted livestock grazing land in acres by alternative for each national forest

National Forest	Live-stock type	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur	Cattle	1,197,000	1,225,000	620,000	1,216,000	1,197,000	1,318,000	1,318,000	1,197,000
Malheur	Sheep	102,000	101,000	55,000	101,000	101,000	101,000	101,000	101,000
Umatilla	Cattle	284,000	298,000	30,000	284,000	284,000	284,000	284,000	284,000
Umatilla	Sheep	60,000	28,000	13,000	42,000	42,000	42,000	42,000	42,000
Wallowa-Whitman	Cattle	408,000	393,000	135,000	422,000	408,000	527,000	527,000	408,000
Wallowa-Whitman	Sheep	25,000	22,000	25,000	25,000	25,000	25,000	25,000	25,000

Table 145 summarizes the rates of recovery to desired range condition. The least responsive alternatives toward range recovery and assumed soil sustainability would be Alternatives A and B for the Blue Mountains national forests. Additionally for the Malheur National Forest, Alternatives D and E-Modified Departure would offer the least response to the desired condition. Alternative C creates conditions in rangeland vegetation which should result in the desired condition the fastest.

Dry non-forested and dry forested sites are generally considered to have low or moderate grazing suitability ratings. Impacts to overall rangeland health of less suitable lands tends to be expressed by greater departures in biotic integrity than soil quality attributes for the same site. It is assumed that this is due to differences in resistance and resiliency characteristics between these two ecological processes (Stringham et al. 2003).

Table 145. Rate of progress towards achieved rangeland vegetation desired condition

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Malheur	Slow to Moderate	Slow to Moderate	Fast	Slow	Slow to Moderate	Moderate to Fast	Moderate to Fast	Slow to Moderate
Umatilla	Slow to Moderate	Slow to Moderate	Fast	Moderate	Moderate	Fast	Fast	Moderate
Wallowa-Whitman	Slow to Moderate	Slow to Moderate	Fast	Moderate	Moderate	Fast	Moderate to Fast	Moderate

Assessment of the areal extent of detrimental soil conditions for the Plan Area and even high use areas is difficult due to the scale of grazing lands and the dynamic nature of management strategies. Livestock grazing effects on soils will generally be concentrated in areas most heavily used by livestock, including corrals, trails, around salting sites, at water developments and near other water sources.

Recreation

Recreation activities effects on soils are related primarily to roads. Dispersed campsites may have compaction and displacement. Locations that are very popular and constantly occupied during the summer and fall, and where adjacent to water, would be expected to have the most impacts.

The effects from recreation for any alternative are not expected to be substantial. Off-road vehicle use, access to dispersed campsites, and concentrated use near water can impact soils (Eckert et al. 1979). This assumption is based primarily on known minimal effects from motorized recreation, which may change if this type of recreation increases in popularity.

Soil Restoration

Although protection of soils from detrimental disturbance is a primary goal of management activities, detrimental disturbance occurs. However, with effective management and mitigation, it can be a short-term effect. Sometimes, especially where historic land use practices resulted in detrimental soil conditions, soil restoration is needed; to restore physical, chemical, and biological properties, suited for natural soil development. In these cases, restoration of soils is an important aspect of forest and rangeland management.

Soil and watershed restoration objectives are similar for each alternative. However, each alternative differs in the amount of land that would receive restoration treatments. Predominant objectives for improved soil and watershed function include:

- improving soil quality and hydrologic function in areas of detrimental soil disturbance,
- reducing road-related sedimentation by reducing road density and hydrologic connectivity of the road system, and
- improvement of forest vegetative conditions.

There are numerous soil restoration opportunities available as mitigations to offset impacts of management activities, in addition to restoration to reduce existing detrimental soil conditions. Examples include:

- Subsoiling to reduce soil compaction associated with roadbeds, skid trails, and landings;
- Road decommissioning and obliteration
    - ♦ Treatment should include use of effective ground cover rates based on site conditions to minimize surface crusting and erosion. Fine slash (less than 100-hour fuels) may be considered as an optimum effective ground cover.
- Organic matter amendments to condition the soil and either grow or act as effective ground cover:
    - ♦ Biosolids (Class A & B), solids from water treatment plants allowed to be land applied (EPA 40 CFR Part 503)
    - ♦ Commercially available manures and soil conditioners
    - ♦ Biochar: charcoal amendment to increase soil activity through improvement of soil/water and nutrient holding capacities. Forest derived biochar maybe best suited.
- Seeding with native vegetation; use of biological organisms and nitrogen fixing shrubs and trees to help restore nutrient cycling processes on degraded sites; and implementation of soil erosion control measures.

Restoration effectiveness in reducing detrimental soil conditions and improving soil function is highly variable depending upon the site conditions, treatment, implementation and the type of ground covers selected for the specific site in need of restoration. The purpose of soil restoration is to improve dynamic properties to aid natural soil functions in the restoration process over time.

This includes improving infiltration and water holding capacity of soils, vegetation and root growth, organic matter accumulation, and soil fertility.

Approximately 80 percent of road-related sediment comes from approximately 20 percent of roads (Nelson 2010). Reduction of road related sediment may include various levels of road decommissioning (such as pulling carsonite signs, drainage structures, barrier construction, additions of woody material and other organic matter additions, reseeding, and culvert removal) and obliteration (such as subsoiling and recontouring). The actual method used to reduce road-related sediment would be determined at the site–specific, project level. Additionally, each level of road decommissioning would have a unique effect to reducing road related sediment.

Removal or additions of forest floor detritus (i.e., organic matter), alters the decomposition process and reduces the amount of available material for soil flora and fauna (Jurgensen et al. 2005, and Busse et al. 2006). The processes of carbon loss from (or gain into) the soil ecosystem can be influenced by management practices. Restoration of soil chemical and biological properties specifically addresses nutrient cycling and availability of soil nutrients and moisture to aid plant growth. Appropriate soil restoration would include fertilization or the addition of organic material. Fertilization rarely occurs on National Forest System lands due to the length of rotation and the efforts needed to reserve organic material onsite. When organic material is lost due to fire or by heavy equipment impacts, the quality of the soil is altered as shown in Figure 24.

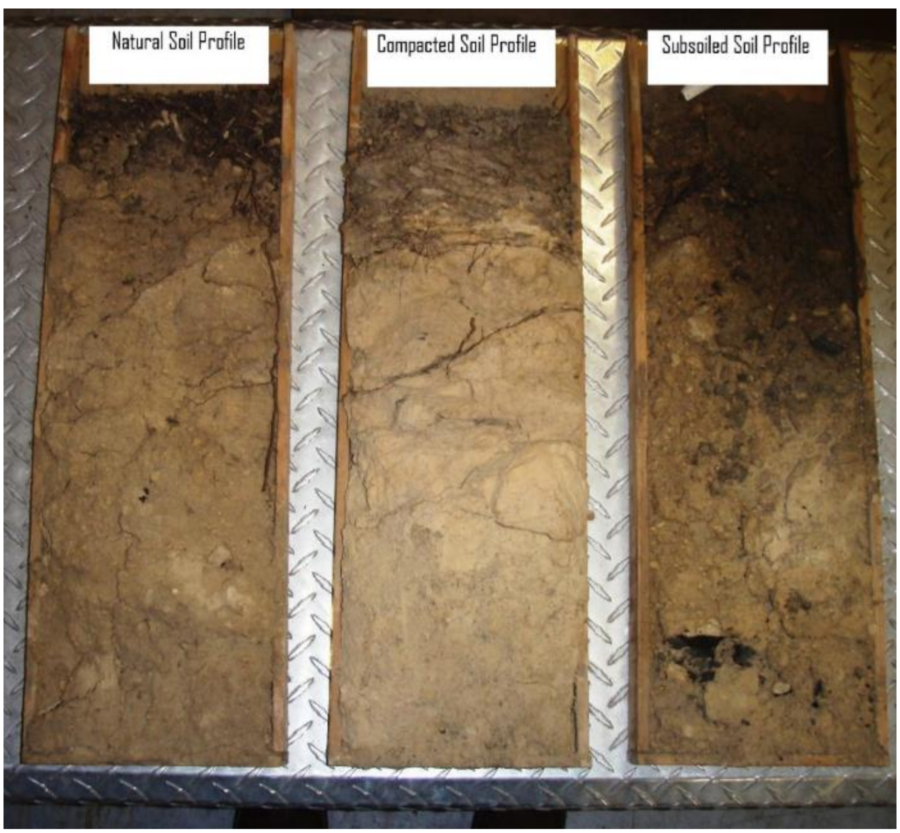


Figure 24. Soil monoliths show natural conditions to altered, compacted and restored by subsoiling. Monoliths were extracted within 30 feet of each other and are representative of the same soil type. (Umpqua National Forest, Diamond Lake Ranger District)

Soil compaction effects seen in the figure illustrates the concern of soil compaction and opportunities of subsoiling. In the comparison between natural (undisturbed) monolith and the compacted monolith, we see the decline in soil structure, loss of voids needed for rooting and air/water exchange and anaerobically reduced color within the compacted monolith. The site of the monolith extraction was visited in 2011 (12 years following extraction), the site of the compacted monolith had lost the organic cover seen in the monolith image and now is exposed mineral surface with a compacted profile.

Conversely, the subsoiled monolith, extracted 6 months after subsoiling; shows physical attributes similar to the natural monolith. Though in the short time of 6 months vegetation had not completely returned for roots to occupy voids in Figure 24, there is an abundance of course to fine voids for roots. Also a soil color return has occurred within the time since subsoiling, though it is likely due to both mineral oxidation from soil fauna and some charcoal that migrated from a burn pile at the extraction site for this monolith.

Any practice that enhances soil productivity and the deposition of plant residues (i.e., shoots, roots, and detritus) to soils increases soil organic matter. Fire can also contribute to soil organic carbon by converting dry plant material into charcoal, which enters the recalcitrant fraction of soil organic matter. Soil carbon can also be enhanced by adding organic matter to the soil (such as manure, plant materials or mulch, biosolids, or biochar). Recent testing on the Umpqua National Forest has shown about a 20 percent increase in water holding capacity of the droughty volcanic ash soils following an application of biochar. It is thought this increase in soil moisture was created by the increase is soil organic matter, in the form of biochar.

The use of biological organisms, including nitrogen fixing shrubs and trees, can restore nutrient cycling processes on degraded sites (such as landings, mining tailings, and roadbeds). These are natural components of the early seral species that establish on high burn intensity areas and can last for decades (Halofsky et al. 2011). Ecological benefits of these nitrogen fixing shrubs and trees are an important component in early successional landscapes. In highly degraded sites, or sites where forest cover has been removed for long periods of time, restoration of soil quality may require the introduction of mycorrhizal inoculants and/or nitrogen fixing plants.

Restoration of soil physical properties that improves the movement of roots, water, and animals through the soil is considered to improve soil productivity. The most obvious changes in soil physical condition are related to soil compaction, which alters soil structure and soil pore space. Over time, natural processes will ameliorate soil compaction, but that may take decades. Burrowing animals and roots may serve to rehabilitate soil compaction over time. Depending on location, freeze/thaw cycles may also serve to rehabilitate soil compaction if the depth of freezing is consistent with the depth of compaction. More typically, however, ameliorating compaction requires mechanical assistance with de-compaction or subsoiling equipment that breaks up the compacted layer.

Subsoiling is characteristically done to treat areas with a high compaction and is generally associated with skid trails, temporary roads, and landings. Froehlich (1981) noted that soil in a skid trail is almost always compacted. The same is true of temporary roads and landings. Restoration of detrimental soil compaction by subsoiling serves to reduce the total area of pre-existing and new detrimental soils within activity areas (Craigg 2000, Archuleta and Baxter 2008). Subsoiling is assumed to effectively mitigate adverse compaction (Andrus and Froehlich 1983, Curran 2007) by breaking up compacted layers; however, some percentage of the soil profile retains dense soil clods that are not decompacted. Subsoiling equipment, if used properly,

lifts and shatters the soil profile to improve infiltration of water and aid in seed capture and create a more favorable seed bed without churning the surface soil.

Soil restoration through de-compaction equipment recreates natural soil functions that accelerate the physical processes that break down soil compaction over time (such as improved infiltration and water holding capacity of soils, vegetation and root growth, and organic matter accumulation).

Subsoiling does not mitigate detrimental soil displacement. An example of this is subsoiling of road beds, which reduces compaction and increases infiltration, but soils remain detrimentally disturbed because the original topsoil is still displaced (Bliss 2006).

Subsoiling can generally be done with either a bulldozer drawn implement or with an excavator mounted implement (Archuleta and Karr 2006). The excavator offers other abilities, such as grapple piling of harvest debris, when not engaged in subsoiling (Archuleta and Karr 2006). Backhoe buckets also have been used to effectively decompact roadbeds, aid in seed capture, and decrease surface erosion. However when they are used ineffectively, or where environmental settings and conditions are inadequate, backhoes can churn soil and may increase soil displacement (Archuleta and Baxter 2008 and Bliss 2006). Tines on brush blades and rock rippers which rip through the soil is not always adequately de-compacted.

A subsoiling operation that churns the soil, will increase rates of organic matter decomposition and increase respiration of carbon dioxide into the air. While not a concern on old roadbeds where little organic matter is found in the soil profile, it may be a concern for productive forest lands. Typically, it is not appropriate to subsoil shallow or rocky soils or to subsoil on slopes with greater than 30 percent rise (Bliss 2006). To maximize fracture potential and minimize soil churning, subsoiling is recommended where soil depth is at least 20 inches. Also to prevent surface soil sealing (Luce 1997) and subsidence (recompaction); it is recommended that subsoiling activities include a treatment of effective ground cover or mulch placement.

Decommissioning a road includes many forms and intensities of treatments and similarly can benefit soils in many forms. The effectiveness of improving detrimental soil conditions and decreasing road-related sediment varies (Bliss 2006). These treatments include pulling carsonite signs, which is the least intensive and least effective to the restoration of soil health. There is also water barring, barrier construction, additions of woody material and other organic matter, reseeding, culvert removal, and obliteration by subsoiling or recontouring.

Recontouring is considered to be the most effective treatment for reducing detrimental soil conditions and is estimated to reduce approximately 80 to 90 percent of road-related detrimental soil conditions (Bliss 2006). While recontouring disturbed hill slopes can result in the most aesthetically pleasing restoration, it is also the most expensive soil manipulation. Due to expense and logistics of equipment needs, recontouring should only be employed where slope stability, or hydrologic function are the primary objective of restoration work.

Minimal additional road construction is projected for the Plan Area. Additionally, decommissioning and mechanical de-compaction of existing authorized and unauthorized roads and areas of detrimentally compacted soils would increase. In Table 146 through Table 148 the acres of improved soil and hydrologic function (forest vegetation treatments) are greatest for Alternative E-Modified Departure and decrease progressively in the order of Alternatives D, E, E-Modified, F, C, B and A, for all three National Forests.

Table 146. Restoration and vegetation activities proposed to improve soil and hydrologic function for Wallowa-Whitman National Forest

Restoration Goals and Objectives	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt E-Mod. Dep.	Alt. F
Veg Treatment[1]	1,800	1,800	900	5,100	3,100	3,100	5,000	2,100
Fuels Treatment[1]	4,100	4,100	3,200	5,100	5,500	5,500	7,300	4,500
Veg Totals	**5,900**	**5,900**	**4,100**	**10,200**	**8,700**	**8,600**	**12,300**	**6,600**
Improving detrimental soil disturbance (acres) (WH2)	no data	450	800	400	600	600s	400	540
Reducing road density (miles)(WH3)	no data	10	15	0	10	11	0	12
Implement erosion control and stabilization measures[2]	no data	200-400	300-500	150-250	200-400	200-400	125-225	180-350

1. 2017 estimate annual forest vegetative conditions improved (WH1)
2. Possible activities include road obliteration and improving forest vegetation conditions on unstable hillslopes.

Table 147. Restoration and vegetation activities proposed to improve soil and hydrologic function for Umatilla National Forest

Restoration Goals and Objectives	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt E-Mod. Dep.	Alt. F
Veg Treatment[1]	1,000	1,000	450	2,900	1,375	1,375	2,650	1,200
Fuels Treatment[1]	2,800	2,800	2,280	3,000	3,200	3,200	4,500	3,000
Veg Totals	**3,800**	**3,800**	**2,730**	**5,900**	**4,575**	**4,575**	**7,150**	**4,200**
Improving detrimental soil disturbance (acres) (WH2)	no data	450	800	400	600	600	400	540
Reducing road density (miles)(WH3)	no data	10	10	zero	10	10	zero	14
Implement erosion control and stabilization measures[2]	no data	200-400	300-500	150-250	200-400	200-400	125-225	180-350

1. 2017 estimate annual forest vegetative conditions improved (WH1)
2. Possible activities include road obliteration and improving forest vegetation conditions on unstable hillslopes.

Table 148. Restoration and vegetation activities proposed to improve soil and hydrologic function for Malheur National Forest

Restoration Goals and Objectives	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt E-Mod. Dep.	Alt. F
Veg Treatment[1]	1,130	1,140	500	4,100	2,350	2,330	4,150	1,500
Fuels Treatment[1]	3,800	3,800	3,100	4,250	5,000	5,000	6,800	4,100
Veg Totals	4,930	4,940	3,600	8,350	7,350	7,330	10,950	5,600
Improving detrimental soil disturbance (acres) (WH2)	no data	450	800	400	600	600	400	540
Reducing road density (miles)(WH3)	no data	10	10	0	12	10	0	12
Implement erosion control and stabilization measures[2]	no data	200-400	300-500	150-250	200-400	200-400	125-225	180-350

1. 2017 estimate annual forest vegetative conditions improved (WH1)
2. Possible activities include road obliteration and improving forest vegetation conditions on unstable hillslopes.

The projected improved soil and hydrologic function will be created by reducing detrimental soil disturbance, implementing erosion control measures, and stabilization to restoring soil function (subsoiling). In Table 146, the highest benefits to detrimental soil disturbance are from Alternative C and decrease progressively in the order of Alternatives E, E-Modified Departure, F, D, B and A. The highest benefits to returning soil productivity (reducing road density) are from Alternative C and decrease progressively in the order of Alternatives F, E-Modified, B, A, D, E-Modified Departure. The highest benefits to erosion control and stabilization measures are from Alternative C and decrease progressively in the order of Alternatives B, A, E, E-Modified, F, D, E-Modified Departure.

Another change in physical soil quality occurs when inherent soil moisture levels are altered. There are two important examples of this occurring throughout the Blue Mountains. First, soils are considered to have been degraded in wet meadow systems and other areas that have been drained due to down-cutting of streams through the area. Typically, organic rich soils form under wet soil conditions due to slow decomposition of plant material. As meadows and wetland areas are drained, this organic material is rapidly decomposed through volatilization and respiration by microorganisms. The soil quality is severely altered, causing a state transition of the type of soil found in the area. Restoration of soils in this area would require reestablishment of the groundwater regime.

The projected improved soil and hydrologic function will be created by reducing detrimental soil disturbance, implementing erosion control measures, and stabilization to restoring soil function (subsoiling). In Table 147 the highest benefit to detrimental soil disturbance are from Alternative C and decrease progressively in the order of Alternatives E, F, B, A, D and E-Modified Departure. The highest benefit to returning soil productivity (reducing road density) are from Alternative F and decrease progressively in the order of Alternatives B, C, E, E-Modified, D, E-Modified Departure. E, E-Modified, C, B, A, E-Modified Departure, D. The highest benefit to erosion

control and stabilization measures are from Alternative C and decrease progressively in the order of Alternatives B, A, E, E-Modified, F, D, E-Modified Departure.

Due to fire exclusion and prior management activities, many areas of the Blue Mountains national forests have become unsustainably overstocked. During low precipitation periods soils do not have the ability to supply moisture to support these overstocked conditions. Depending upon the type of soil, this condition can result in an elevated risk for soils with a low capacity to hold water where there is an excessive amount of vegetation, increasing the potential for drought stress and forest health risks (such as insects and diseases).

Overstocking on some grass derived soils may have reduced the soils quality or the inherent ability to supply water to vegetation communities. This is very likely to have occurred were shallow Mollisols occur, but now carry a stand of trees over grasses. Along with these major changes in landscape dynamics, degradation of soils through removal of organic matter, displacement of surface soils, and soil compaction further exacerbate these conditions.

The projected improved soil and hydrologic function will be created by reducing detrimental soil disturbance, implementing erosion control measures, and stabilization to restoring soil function (subsoiling). In Table 148 the highest benefit from improving detrimental soil disturbance are from Alternative C and decrease progressively in the order of Alternatives E, F, B, A, C, E-Modified, D and E-Modified Departure. The highest benefit to returning soil productivity (reducing road density) are from Alternative E, and decrease progressively in the order of Alternatives F, B, C, E-Modified, D, E-Modified Departure. The highest benefit to erosion control and stabilization measures are from Alternative C and decrease progressively in the order of Alternatives B, E, E-Modified, F, D, and E-Modified Departure.

Climate Change

Climate change effects on soils in the West are not well known, but changes in the amount and timing of precipitation, wind, snowpack, stream flow, and the frequency and severity of floods, fires, and droughts have important implications for soil carbon sequestration, soil water retention, and erosion (Halofsky and Peterson 2017)

Elevated carbon dioxide increases carbon supply below-ground through increased plant biomass, stimulated root growth, and root secretions in soils (Pendall et al. 2006, Ainsworth and Rogers 2007, and Ainsworth and Long 2005). Soil organic matter exerts strong influence on nutrient balance and can also influence soil water holding capacity and populations of soil organisms (Carney et al. 2007). Any gains of soil carbon will occur faster in grassed environments over forested environments. Typically, forests have lower carbon inputs into the soil and a reduced rate of decomposition of organic matter (Zhou et al. 2012).

“Organic matter decomposition is a critical factor in assessing the possible impacts of future climate change on soil carbon pools” (Jurgensen et.al. 2005). These impacts have the potential to moderate one another relative to carbon emissions to the atmosphere (Kirschbaum 2000), but the effect is sensitive to changes in average temperature and changes in temperature variation (O’Donnell 2011). Indirect effects of warming temperatures and other climate changes on soil moisture availability and nutrient supply may alter soil and plant processes in unexpected ways (Pendall et al. 2006).

Increasingly warm temperatures and associated changes in rainfall patterns, increased evaporative stress, and declines in snowpack are expected to cause a decline in soil moisture availability and possibly result in decreased soil organic matter content. Reduced soil moisture availability may in

turn result in increased drought stress, making forests more susceptible to mortality from insect infestations and large severe fires. East of the Cascade Range (i.e., the Blue Mountains), soil moisture decline and increased drought stress on forests is projected to increase overtime. Increased plant growth driven by increased temperatures and carbon dioxide could also increase demands on available soil moisture. Soil texture, organic matter content, and depth is important to soil water holding capacity, and hence to an ecosystem's vulnerability to drought.

Soil erosion rates are expected to change in response to changes in climate for a variety of reasons, including the erosive power of rainfall. If rainfall amounts and intensities increase in the Blue Mountains, erosion will also increase. Other factors that could contribute to soil vulnerability, or changes in rates of water runoff and soil erosion, include:

- Changes in the amount of plant cover as ecosystem distributions shift
- Changes in amounts of litter as a result of changes in decomposition and plant production rates
- Changes in soil moisture due to shifting precipitation regimes and evapotranspiration rates
- Changes in soil organic matter concentrations
- A shift of winter precipitation from snow to rainfall, or changes in the frequency of rain-on-snow events and subsequent flooding
- Increased rain and snow runoff can also have implications for hill slope stability

Observed and anticipated increases in fire frequency and severity in the Blue Mountains as a result of climate change also have implications for soils. High severity burns lead to higher rates of soil loss from erosion, greater duff reduction, loss in soil nutrients, and soil heating (McNabb and Swanson 1990 and Hungerford et al. 1991).

Management strategies that facilitate the conservation of soils in the face of climate changes include: protecting the soil surface horizon effective ground cover by retaining forest floor detritus and reducing wildfire risk which can help to minimize above ground vegetation losses from uncharacteristically severe or frequent fire, or overgrazing.

Cumulative Effects

The implementation of Alternatives D, E-Modified and E-Modified Departure have a risk of exceeding detrimental soil condition limitations. Proposed harvest activities displayed within Table 137 through Table 139 show the heightened rates of annual harvest. This assumption is based on the following factors:

- Experiences of current project implementation.
- Proposed intensity of harvest compared to current rate of harvest.
- Most harvest being ground based in the proposed alternatives.
- Ground-based harvest produces the most detrimental soil conditions per acre.

Proposed actions would be designed to strike a balance between potential site impacts and the feasibility of operations. Existing soil disturbance is scattered across the Plan Area, and is concentrated on more level ground that is readily accessible primarily in the form of old skid trails and landings. Existing detrimental soil conditions often are referred to as legacy disturbance and will be factored into assessments of cumulative effects for new management actions on a site-specific level. Table 149 displays cumulative effects to detrimental soil disturbance by alternative for each national forest. Due to the assumed range of existing detrimental soil conditions, Table

149 displays both a low and high range for the cumulative detrimental soil conditions, calculated from combining existing detrimental soil conditions in Table 136 and Table 134, and assumed detrimental soil conditions in Table 137 through Table 139.

Under the alternatives with the highest rate of harvest, the capacity (Forest Service labor force) to ensure best management practices and project design criteria regulation are followed; detrimental soil conditions may unintentionally be exceeded. The order of impact from highest to lowest would be Alternative D followed by E-Modified Departure, E-Modified, E, F, B, A, and then C.

Table 149. Cumulative acreage range* of estimated detrimental soil conditions over 10 years associated with timber harvest activities by alternative for each national forest

National Forest	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt E-Mod.	Alt E-Mod. Dep.	Alt. F
Malheur	52-257	52-258	48-254	72-278	58-264	57-263	64-270	54-259
Umatilla	38-194	35-192	35-191	48-204	40-197	40-196	46-203	39-196
Wallowa-Whitman	29-124	29-125	26-122	47-142	34-130	33-129	40-136	30-126

*Range represents the lowest and highest predictions. Acres rounded up to thousand-acre increments.

Air Quality

Air pollution has the potential to impact a variety of resources on National Forest System lands in the Blue Mountains, including visibility, water, soils, vegetation, and sensitive species of flora and fauna. Air pollution also has potential to impact human health. Activities, such as timber harvesting, livestock grazing, oil and gas well drilling and operations, road construction or maintenance, and prescribed fire, produce emissions that may affect air quality in and around the national forests.

Changes Made Between the Draft and Final Environmental Impact Statements

Aside from the global changes throughout this environmental impact statement described in the Preface to this document, the following changes were made specifically to this section:

Revised Forest Plan Content: The forest plan design criteria was modified to add a standard for air quality. The standard states that planned (prescribed) burning will be conducted in compliance with established State smoke management plans for Oregon and Washington. Additionally, air quality related values (AQRVs) baseline and trends were added to this section as pertains to the protection of Class I areas.

Air Quality – Affected Environment

Key indicators:

- Ambient air quality
- Visibility
- Acres of wildland fire(s)
- Acres of prescribed fires or tons of fuels treated on National Forest System lands

Federal land management agencies have the unique responsibility to protect the air, land, and water under their respective authorities from degradation associated with air pollution emitted outside the borders of agency lands as well as from the impacts of air pollutants produced within those borders. These mandates are established through legislative and regulatory requirements including the Clean Air Act of 1963 (Public Law 88-206, as amended through Public Law 108-201 [2004]), the Air Quality Act of 1967 (Public Law 90-148), and the Regional Haze Rule of 1999.

The Clean Air Act names six criteria pollutants: carbon monoxide, lead, nitrogen dioxide, ozone, sulfur dioxide, and particulate matter as both PM_{10} (particulate matter less than 10 microns in diameter) and $PM_{2.5}$ (particulate matter less than 2.5 microns in diameter). These pollutants create the framework for which National Ambient Air Quality Standards (NAAQS), which are updated periodically as new science becomes available about their effects. A community that does not meet or attain the National Ambient Air Quality Standards is designated by the Environmental Protection Agency (EPA) as a nonattainment area and the State must develop and implement a plan to bring the area back into attainment. The city of La Grande was named a nonattainment area for particulate matter (PM_{10}) in 1991 and is the only area in the Blue Mountains to be so named. Once in attainment, the State must develop a maintenance plan to ensure the area does not return to nonattainment status. An air quality maintenance plan was developed by Oregon Department of Environmental Quality (ODEQ), which resulted in control measures for sources of particulate matter within the La Grande Urban Growth Boundary. The Environmental Protection Agency approved a revised Air Quality Maintenance Plan for La Grande and changed its status to attainment, effective July 19, 2006. La Grande is now designated as an Air Quality Maintenance Area for PM_{10} and is the only area with this designation in the Blue Mountains. Emissions from the Forest must not jeopardize this area's attainment status, nor cause or significantly contribute to another community from becoming a nonattainment area.

The Clean Air Act also established three classes of airsheds, designated Classes I, II, and III, with varying levels of protection. Class I provides the highest level of protection and includes Forest Service wilderness areas larger than 5,000 acres that were designated before August 1977. Three Class I areas are located in the Blue Mountains: Strawberry Mountain Wilderness Area, Eagle Cap Wilderness Area, and Hells Canyon Wilderness Area.

The 1977 amendments to the Clean Air Act gave Federal land managers, which includes the Forest Service, an "affirmative responsibility" to protect the natural and cultural resources of Class I areas from the adverse impacts of air pollution. Federal land manager responsibilities include the review of air quality permit applications from proposed new or modified major pollution sources near these Class I areas. If, during a permit review, a Federal land manager demonstrates that emissions from a proposed source will cause or contribute to adverse impacts on the air quality related values of a Class I area, the permitting authority, typically the State, can deny the permit. Air quality related values are a resource, as identified by the Federal land manager for one or more Federal areas that may be adversely affected by a change in air quality. The resource may include visibility or a specific scenic, cultural, physical, biological, ecological, or recreational resource identified by the Federal land manager for a particular area.

Table 1 presents the air quality related values, sensitive receptors and indicators for the Class I areas of the Blue Mountains (USDA Forest Service 2013). The characteristic of an air quality related value, which is first modified by air pollution, is referred to as a sensitive receptor. The indicator is a measurable quality of a sensitive receptor that responds to air pollution, thus is the focus of monitoring efforts.

Table 150. Air quality related values, sensitive receptors, and indicators for Class I areas of the Blue Mountains

Air Quality Related Value	Sensitive Receptor	Indicator
Visibility	Scenic Views	Regional Haze
Flora	Lichens	Changes in community composition and concentrations of nitrogen, sulfur, copper, cadmium, chromium, lead, mercury, and nickel
Fauna	Fish	Concentration of methyl mercury
Water	Water Chemistry	Acid neutralization capacity (ANC) and the ratio of dissolved inorganic nitrogen to total phosphorous (DIN:TP)

Visibility is also protected through the 1977 amendments to the Clean Air Act. At that time, Congress set a national goal for visibility as "the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from manmade air pollution." After a decade of monitoring visibility in Class I areas such as Grand Canyon National Park, in 1999 the U.S. Environmental Protection Agency announced a major effort to improve air quality in national parks and wilderness areas. The Regional Haze Rule calls for State and Federal agencies to work together to improve visibility in 156 national parks and wilderness areas. The rule requires the States, in coordination with the Environmental Protection Agency, the National Park Service, U.S. Fish and Wildlife Service, the U.S. Forest Service, and other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairment. The first step in this process was to establish baseline conditions at all Class I areas. After baseline measurements are obtained, these agencies must work together to reduce regional haze on the worst days to natural conditions by 2064, and prevent the best days from degrading.

In the Blue Mountains, visibility monitoring is accomplished through Forest Service participation in the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. There are two Interagency Monitoring of Protected Visual Environments monitoring stations in the Blue Mountains, one in the Starkey Experimental Forest and Range Station (which represents Strawberry Mountain and Eagle Cap Wilderness Areas) and the other at the Bowman Dam in the Hells Canyon National Recreation Area. The Interagency Monitoring of Protected Visual Environments monitor stations collect aerosol samples that are then analyzed to obtain a chemical profile of the airborne particles that affect visibility.

Using the monitoring data collected from 2000 to 2004, baseline visibility was established for Strawberry Mountain and Eagle Cap Wilderness Areas—these areas are dominated by sulfate on the best days, and organic carbon on the worst days (ODEQ 2010). However, on the best days, organic carbon is also significant, while on the worst days, the contribution of nitrate is much higher than Western Oregon Class I areas. In looking at the pollutant species variations, the organic carbon impacts during the year suggests the same pattern of summer wildfire and prescribed burning in spring and fall as other Oregon Class I areas. There is also a pattern of high nitrate impacts during the winter months. Much of this can be attributed to industrial sources, primarily the PGE Boardman power plant, which is a large emissions source of nitrogen oxides, and has been identified through modeling to be a significant contributor to regional haze. Because these impacts occur in wintertime, this suggests that meteorological

conditions play a major role. Cold temperatures and low level inversions likely intensify these impacts, and account for the high impacts noted in early 2004.

The Hells Canyon Wilderness is dominated by both organic carbon and sulfate on the best days, and a significant contribution of nitrate (rather than organic carbon) on the worst days. This nitrate contribution is even more pronounced than at Strawberry Mountain and Eagle Cap Wilderness Areas. Most of the nitrate impacts appear during the winter months, suggesting meteorological conditions are playing a major role here. It is likely that the topographic features of Hells Canyon, combined with cold temperatures and low level inversions, greatly intensify these impacts during the winter. Again, the PGE Boardman power plant is believed to be the largest contributor, as indicated by the modeling and analysis of impacts.

The standard visual range (a visibility metric) was calculated by averaging the measurements for the worst days (20 percent of the total) and the best days (also 20 percent of the total). The results are values for the worst-case day and best-case day. During the baseline period for the Starkey site, the standard visual range was 57 kilometers (35 miles) for the worst-case days. The standard visual range for the best-case days is more than four times better at 247 kilometers (153 miles). For the Bowman Dam site, the standard visual range for the worst-case days was 57 kilometers (35 miles), and it was 238 kilometers (148 miles) for the best-case days. Natural conditions during worst-case days (average) are 156 kilometers (97 miles) for the Starkey Experimental Forest and Range site and 176 kilometers (109 miles) for the Bowman Dam site.

Lichen monitoring plots were established between 1997 and 2002 in all three Class I areas of the Blue Mountains, and repeat visits were conducted approximately once every 10 years afterwards. The lichen were evaluated for concentrations of elemental metals including cadmium, chromium, copper, nickel, lead, zinc, and mercury. The concentrations were compared to the mean and 98 percentile range of values from all other lichen plots in the region. The 98^{th} percentile value range is identified as the regional threshold. Thus, any plot with a concentration of a metal exceeding this value is of interest. Additionally, sulfur and nitrogen concentrations and deposition rates were evaluated as determined from the lichen and compared with critical loads (the concentration above which is known to adversely impact the sensitive receptor). The lichen community data is determined by the number and abundance of species found at each site. The community data score determines the plot’s position along regional pollution and climate gradients. Clean plots have more biodiversity than other plots. Tracking changes in community plot scores helps determine trends in sensitive flora species biodiversity, some of which are driven by air pollution and some may be affected by changes in climate.

In the Strawberry Mountain Wilderness, the sites were founds to be relatively clean with the exception of lead, which exceeded the regional threshold during the baseline period (1997-2002). Trend data was not yet available at the time of writing this document. No plots in the Strawberry Mountain wilderness exceeded critical loads for nitrogen or sulfur deposition. Biodiversity of lichen communities were determined to be good during the period of 1993-2002, best during the next 10-year period (2003-2012), but only fair in 2013. However, at the time of this analysis it was not yet possible to determine if the differences are statistically significant.

In the Eagle Cap Wilderness, at least one plot exceeded the regional threshold concentration for Chromium, nickel, zinc, nitrogen, and sulfur. No change has been observed since then. At least one plot exceeded the critical load for nitrogen in rounds 1 (1997-2002) and 2 (2003-2012) but

not yet in round 3 (2013). Biodiversity was scored as good for both the baseline visits and the first round of repeat visits.

In Hells Canyon Wilderness, elemental concentrations of nitrogen and zinc were above regional thresholds for both the baseline period and the first round of repeat visits. There was some moderate evidence that copper and zinc increased during this first 10-year period of repeat sampling, but not enough to exceed regional thresholds. There have been no changes in concentrations detected yet in the current round of repeat visits. Critical loads for nitrogen deposition have been exceeded in at least one plot. The community composition scores resulted in this area being ranked as poor in terms of biodiversity.

Additional studies conducted by the Forest Service revealed a very steep gradients of ammonia deposition with proximity to the river, and the instrumented measures showed seasonally high values that aligned timewise with peak algal growth, oxygen deprivation, and highest pH values in the river which point to the river as a source of ammonia (Geiser et al. 2008). This could be a concern regarding impacts on the rock paintings—made with easily oxidized clay pigments—but there is also a lot of regional ammonia in the fine particulate matter which likely originates from agricultural sources, as measured by the IMPROVE station at Bowman Dam. A back-trajectory analysis also showed that some of the ammonia originates in California. Since then, Oregon and Idaho established a total maximum daily load for the Snake River, which may cause a change in the activities that generate ammonia. Further monitoring will determine if conditions have improved.

In 2011, the Forest Service, working in partnership with the U.S. Geological Survey and the Oregon Department of Fish and Wildlife conducted a study of methyl mercury impacts on the Wallowa Whitman National Forest (Eagles-Smith et al. 2013). Fish from 28 lakes located in high-elevation, subalpine lakes were sampled. Many of these lakes were located in the Eagle Cap and Hells Canyon Wilderness areas. The goals of the study were to (1) assess the magnitude of mercury contamination in small-catchment lakes to evaluate the risk of atmospheric mercury to human and wildlife health, (2) quantify the spatial variability in fish mercury concentrations, and (3) determine the ecological, limnological, and landscape factors that are best correlated with fish total mercury concentrations in these systems.

Across the 28 study lakes, mean total mercury concentrations of resident salmonid fishes varied as much as 18-fold among lakes. Importantly, the top statistical model explained 87 percent of the variability in fish total mercury concentrations among lakes with four key landscape and limnological variables—catchment conifer density (basal area of conifers within a lake's catchment), lake surface area, aqueous dissolved sulfate, and dissolved organic carbon. The basal area of conifers within a lake's catchment was by far the most important variable explaining fish total mercury concentrations, with an increase in total mercury concentrations of more than 400 percent across the forest density spectrum. Across all study lakes, fish total mercury concentrations ranged from 0.004 to 0.438 milligrams per kilogram wet weight. Only a single individual fish sample exceeded the U.S. Environmental Protection Agency's human health tissue residue criteria of 0.3 milligrams per kilogram wet weight. However, 54 percent of fish (N=177) exceeded the more stringent tissue residue criteria (0.04 milligrams per kilogram wet weight) adopted by the Oregon Department of Environmental Quality to better protect subsistence fishers. Additionally, 2 and 10 percent of fish exceeded levels associated with reduced common loon reproduction and behavior, respectively, whereas 25 and 68 percent of fish sampled exceeded concentrations deemed protective of mink and kingfisher, respectively. These results suggest that total mercury concentrations may be present in these lakes at levels associated with ecological

risk. It is important to note however, that accurate inference on potential impairment cannot be made within the context of this study design and further research is needed to better quantify these risks.

Surface water chemistry was studied at 15 lakes in the Eagle Cap Wilderness (Eilers et al. 2000). The results of the study showed that the lakes are insensitive to chronic acidification associated with acid deposition. This is because natural weathering reactions could compensate for any realistic increases in acid deposition. While the study did not address the risk of episodic acidification associated with snowmelt runoff, it did state that the current risk of either chronic or episodic acidification is probably low given the available information of regional emissions of nitrogen and sulfur.

The study also evaluated unwanted nutrient enrichment of these lakes. Evaluation of the transparency of the lakes, and nitrogen and phosphorous concentrations, indicated that the lakes appear to be nitrogen-limited systems. As such, efforts to maintain these and related lakes in their current condition should focus on minimizing anthropogenic sources of nitrogen to these watersheds.

Within the Blue Mountains, smoke from wildland and prescribed fires is currently the dominant source of air pollution. Smoke emissions from prescribed fires on National Forest System lands are regulated by State smoke management plans. In Oregon, the smoke management plan is regulated by the Oregon Department of Forestry. The objectives of the Oregon Smoke Management Plan, as stated in OAR 629-048-0010, are to:

1. Prevent smoke from prescribed burning on forestlands from being carried to or accumulating in smoke sensitive receptor areas or other areas sensitive to smoke, and provide maximum opportunity for essential forestland burning while minimizing emissions,
2. Coordinate with other state programs,
3. Comply with state and federal air quality and visibility requirements,
4. Protect public health, and
5. Promote the reduction of emissions by encouraging cost effective utilization of forestland biomass alternatives to burning and alternative burning practices.

The Oregon Smoke Management Plan identifies Baker City, La Grande, Enterprise, Burns, John Day, and Pendleton as smoke sensitive receptor areas within the Blue Mountains. To prevent smoke from entering these areas, burners must coordinate with the Oregon Department of Forestry meteorologist in Salem. The meteorologist evaluates weather forecasts and based upon their historic knowledge and experience with burning around the state, they issue guidance to land managers to only conducting burning when weather conditions are favorable for ventilating smoke up and away from these population centers. The amount of burning that can take place is limited by tons of particulate matter emitted and by distance upwind of a smoke sensitive area. If a smoke intrusion does occur, an investigation of the cause is initiated and lessons learned are applied to avoid the situation from reoccurring.

The Oregon Smoke Management Plan also limits the amount of PM_{10} emissions allowed from prescribed burning in Northeastern Oregon. From 1994 through 2008, PM_{10} emissions from the Malheur, Ochoco, Umatilla, and Wallowa-Whitman National Forests were limited to a combined 15,000 tons per year. PM_{10} emissions averaged approximately 4,150 tons per year from 1994 through 2001, or about 28 percent of the emissions allowed by the Oregon Smoke Management

Plan. The Oregon Smoke Management Plan emissions cap of 15,000 tons PM_{10} per year from prescribed fires and fuel treatments has never been exceeded.

Both Washington and Oregon's smoke management plans also have rules, which attempt to keep smoke from prescribed burning out of Class I areas. These rules are consistent with the state regional haze plans, which all try to reduce haze in these scenic areas adding to the public enjoyment of these areas.

The State smoke management plans are reviewed and revised periodically. As of 2018, both Oregon's and Washington's smoke management plans were undergoing review.

Air Quality Tradeoffs between Prescribed Fire and Wildland Fire Emissions

Smoke from wildland fires is the most prevalent source of impacts on air quality in the Blue Mountains (but not always from fires here). Smoke from prescribed and wildland fires contains a rich and complex mixture of gases and aerosols. Primary emissions not only include particulate matter, but also carbon monoxide, sulfur dioxide, nitrous oxides, volatile organic compounds (Liu 2004), and air toxics including mercury (Friedli et al. 2003).Particulate matter (PM_{10}, $PM_{2.5}$) in wildland fire smoke is of greatest concern because of known human health effects. The effects of smoke range from eye and respiratory tract irritation to more serious disorders, including reduced lung function, bronchitis, exacerbation of asthma and heart failure, and premature death (U.S. EPA 2016). Most of our understanding on the health effects of wildfire smoke are derived from studies of urban particulate matter, specifically fine particulate matter. These studies have found that short-term exposures (days to weeks) to fine particles, a major component of smoke, are linked with increased premature mortality and aggravation of preexisting respiratory and cardiovascular disease. Children, pregnant women, and the elderly are also especially vulnerable to smoke exposure. In addition, fine particles are respiratory irritants, and exposures to high concentrations can cause persistent cough, phlegm, wheezing, and difficulty breathing. Exposures to fine particles can also affect healthy people, causing respiratory symptoms, transient reductions in lung function, and pulmonary inflammation. Particulate matter may also affect the body's physiological mechanisms that remove inhaled foreign materials from the lungs, such as pollen and bacteria.

The existing wildland fire regime is significantly different than it was historically because of increased fuel loading, development of fuel ladders, and increases in stand density. Approximately 10 percent of acres burned now are nonlethal (to trees) underburns, while approximately 31 percent of acres burned were nonlethal underburns historically. Stand replacing fires consume much more fuel and produce much more smoke than nonlethal fires, which usually burn with fairly low surface fire intensities in the understory. Brown and Bradshaw (1994) found that emissions were greater from current fires, even though they burn fewer total acres than what burned historically, because consumption of fuel per unit area burned is greater in the current period.

Prescribed fire is used to reduce fuel loads and may be conducted in conjunction with, or following mechanical fuel treatments, forest thinning, or timber harvest. In combination, these actions can be used to reduce future fire risk, depending on their areal extent and location on the ground. Prescribed fires are ignited when fuel moisture and meteorological conditions are optimal for reducing total fuel consumption. Prescribed fires are planned for times when smoke will be dispersed away from populated areas and when weather conditions are favorable for controlled burning. However, wildfires typically burn during the summer time, and not necessarily under

meteorological conditions favorable for the transport and dispersion of smoke away from communities.

Smoke can adversely affect human health, deter tourism, alter outdoor activities, and outdoor public events. Smoke from wildfires not only covers larger geographic areas than prescribed burning, it also lasts longer and also typically has much larger concentrations than smoke from prescribed burning. Fuel treatments can reduce the risk of wildfire spread and they can reduce the air quality impacts from wildfires in the process by reducing acres burned and the amount of fuel burned in those areas that do burn. However, the smoke emitted during a prescribed burn can negatively impact people and communities if not conducted managed properly.

While increasing prescribed fires can have temporary negative impacts on air quality, in the long term, the acute impacts to air quality from wildland fires can be reduced as a result (Weise et al. 2003). During the last 10 years, measurements of PM_{10} from wildland fires in urban areas well exceeded the National Ambient Air Quality Standards, and State regulators and scientists found it common for these episodes to last several days. Similarly in 2015, multiple large fires occurred nearly simultaneously in Washington, Oregon, and Idaho and adversely affected air quality across the region for extended periods. Impacts to populated areas from prescribed fire emissions can be more frequent. Although smoke emissions may be within established health standards for PM_{10}, it has been observed that smoke impacts may still be apparent in sensitive groups or individuals (children, elderly individuals, and persons with existing cardiopulmonary infections or respiratory disease). In response, the U.S. Environmental Protection Agency established National Ambient Air Quality Standards for $PM_{2.5}$ (U.S. EPA 1998).

Analysis Assumptions

For the anticipated effects on air quality in the Class I airsheds, fire ignitions are the primary source of visual impairment. Refer to the “Wildland Fire” section for estimates of fire by type and by alternative.

It is assumed that the Forest Service will continue to meet its affirmative responsibility under the Clean Air Act by reviewing and responding to comments on proposed major actions that require a permit to discharge air pollution and are subject to the Prevention of Significant Deterioration rules. It is further assumed that the States will respond to any concerns of the Forest Service by requiring emission controls on such sources that will result in de minimis adverse impacts to air quality related values in the Class I areas of the Blue Mountains. It is further assumed that visibility will continue to improve in these Class I areas consistent with the goals of the Regional Haze Rule. Currently, States are required to develop reasonable progress plans to continue to improve visibility in the Class I areas.

All prescribed burning on National Forest System lands will be conducted in compliance with applicable State smoke management plans. Smoke from prescribed fires would be managed by burning on days when air quality degradation can be minimized. How well the smoke will disperse is a key consideration in prescribed fire burning planning, and coordination will help ensure that prescribed fires will not violate the National Ambient Air Quality Standards for particulate matter. For all prescribed fire activities, site-specific environmental analyses will be conducted in accordance with agency direction in place at that time.

Legal considerations regarding smoke produced from wildland fire and prescribed fire use fall under the Environmental Protection Agency’s Exceptional Events Policy. When exceptional events occur, normal planning and regulatory processes established by the Clean Air Act are not

required. Properly managed prescribed fire and wildland fire use activities are exceptional events according to the policy, and wildland fire is considered a natural event; pollution caused by these events is not subject to violations of National Ambient Air Quality Standards.

For all Forest Service site-specific projects, road dust would be evaluated if it is expected to cause or contribute to violations of National Ambient Air Quality Standards. Mitigation measures to reduce impacts to air quality may include: road surface treatments, seasonal use restrictions, and time of day restrictions; applying dust abatement products or road watering; and requiring lower speeds on gravel and native surface roads.

Air Quality – Environmental Consequences

Key Indicator: Potential particulate emissions generated from prescribed fire

Effects Common to All Alternatives

Both wildland fires and prescribed fires would generate smoke and particulates that could temporarily degrade visibility and ambient air quality conditions in downwind areas. In general, the risk of adverse air quality impacts from fires will increase with the acreage burned, but is still dependent on fuel and weather conditions as well as downwind distance from fires to sites of impact. While daytime smoke is often well dispersed, smoldering fuels overnight, trapped under the nocturnal inversion can lead to smoke draining down river valleys and enter communities. Smoke typically clears out the next morning after the inversion breaks with the heating of the sun.

Smoke from prescribed burning may also enter Class I areas, but it tends to be minimized as the State smoke management plans requires efforts to be made to keep the main plume out of the Class I areas. However, some residual smoke may contribute to regional haze and could diminish views. Prescribed burning typically occurs during the spring and fall, and not during the summer when visitors to the Class I areas increase substantially. During the summer, smoke from wildfires may have a much more widespread and more visible impact, and prescribed burning may actually reduce the impacts if the wildfire interacts with fuel treatments.

It should be noted that some fires are not managed solely for suppression, as it may be too dangerous to send in firefighters. In such cases these fires may be long lasting and so may be the smoke associated with them. Under such cases, the smoke from these fires can affect visibility both within and outside of the Class I areas. Additionally, the smoke may enter communities, affect public health, tourism, and outdoor activities. In the case of all wildfires, the Forest Service participates in an interagency effort to forecast, monitor, and communicate to the public about where and when to expect smoke and guidance for how to minimize exposure. In the past few years, this information has been posted on state smoke blogs such as the Oregon, Washington, or Idaho Smoke Blog.

Effects to air quality from permitted livestock would be negligible. Livestock grazing can generate dust, which can affect visibility and particulate levels. Dust impacts are expected to occur only in localized areas and for limited and short durations. Overall, the effects would be undetectable on an allotment, county, or forestwide scale, and the effects of livestock grazing on air quality would not vary between alternatives.

Impacts to air quality resulting from national forest transportation system use may include vehicle emissions and dust from traffic on unpaved roads. These effects typically are localized and temporary, and their extent depends on the amount of traffic. Dust from unpaved roads increases with dryness as well as vehicle weight and speed.

Motor vehicle recreation occurs year-round. Summer use includes off-highway vehicles. Localized impacts from traffic on unpaved roads (dust) have not adversely affected air quality in sensitive areas (such as those with important scenic vistas). As use of the national forest transportation system increases with greater visitation, road dust impacts to sensitive areas may need to be addressed. Effects of motor vehicle emissions on air quality are not expected to vary from the existing condition for any of the alternatives. Most of the effects of motor vehicle recreation are expected to be localized and temporary.

Winter motor vehicle recreation is mostly limited to snowmobiles. Emissions from these vehicles include carbon monoxide, oxides of nitrogen, and particulate matter. While snowmobiles can produce what is referred to as nuisance emissions, the potential for conflict is relatively low and of short duration (except within small, localized areas).

Effects from Each Alternative

None of the alternatives are expected to substantially change existing air quality. Temporary reductions in visibility and fine particulate matter increases may occur on the National Forests or in population centers downwind from sizeable wildland fires.

Even though the effects of alternatives are expected to be localized, both wildland fires and prescribed fires generate smoke and particulates that can temporarily degrade visibility and ambient air quality conditions in downwind sensitive areas. Alternatives with the most fuels treatment (prescribed fire) acres proposed are Alternatives E-Modified Departure, E-Modified, E, and Alternative A. Alternatives with an intermediate amount of fuels treatment are Alternatives B and F. Alternative D proposes the least amount of fuels treatment (prescribed fire). Alternatives that emphasize natural processes would have the greatest potential for wildland fire and the most acres potentially impacted. Alternative C includes the most prescriptions that would emphasize natural processes.

Cumulative Effects

Cumulative effects include the list of past, present, and reasonably foreseeable future activities considered with regard to cumulative effects to air quality. Generally, long-term air quality impacts would likely come from adjacent communities as populations increase. Emissions could come from both mobile and stationary sources. Mobile source contributors include vehicle exhaust, dust from construction activities, and dust from road traffic within and near the Blue Mountains. Stationary source contributions from outside the national forests include industrial and commercial operations.

Only minor road construction would occur for any alternative. The cumulative effects of road construction, reconstruction, or maintenance on air quality would not vary between alternatives and would contribute only a small amount of the road-related air pollution in the region. Recreational traffic on national forest roads for all alternatives is expected to increase in response to an increasing population. Overall, air quality impacts generated by recreational use of roads would not vary between the alternatives. As growth continues, pollution generated by vehicles would increase. The cumulative road-related effects on air quality would not vary between the alternatives.

Cumulative effects of motor vehicle travel on air quality are unique in that past impacts to air quality are not usually evident. The emissions associated with motor vehicle travel would be cumulative only with local emission sources described in the affected environment. Since motor

vehicle emission sources within the national forests would be localized and transient, actual cumulative combinations of emissions would be minor and would not result in significant effects.

Smoke from wildland and prescribed fires can adversely affect air quality. Private lands, state lands, and lands managed by the Bureau of Land Management surround the plan area. Smoke from prescribed burning operations on these lands could individually, or in combination with other fires, affect air quality in the national forests and in surrounding communities. Burning activities are coordinated to help prevent the cumulative effects of these burns from unacceptably impacting air quality. For all alternatives, wildland fire would continue to periodically cause temporary deviations from air quality standards.

For all alternatives, cumulative effects from Forest Service management activities on air quality would be minor, and in general, temporary and localized. All of the three national forests currently meet state and Federal air quality standards and show no degradation to visibility or other air-quality-related values. Compliance with local, state, and Federal air quality regulations would ensure that Forest Service management activities for any of the alternatives would continue to protect air quality. Management activities would not degrade the air quality of surrounding areas. Oregon and Washington have regulatory authority for controlling emissions, including those with potential to adversely impact national forest resources.

The cumulative effects of smoke could be significant when conditions for smoke dispersal are not satisfactory. Smoke and other pollutants that originate from outside the plan area that would contribute to visibility impairment would be the same for all alternatives, but their contributions could mask differences between alternatives.

Emissions from all fire types are expected to decrease through time (50 to 100 years) when residual fuel levels and landscape conditions approach historic accumulations. Climate change may make this prediction less certain.

Effects of Climate Change on Air Quality

Climate change will continue to affect air quality, primarily through changes in fire regimes. A warmer climate, reductions in snowpack, changes in the timing of snowmelt, early declines in soil moisture, changes in the timing and length of the growing season, and increased drought have already lead to more frequent fires, more severe fires, earlier initiation of the fire season, and a longer fire season in the western United States relative to historical levels (Westerling et al. 2006). With these changes, the contribution of fire to regional haze and reduced visibility is expected to increase in some areas (McKenzie et al. 2006).

Most sources of greenhouse gas emissions are point source; however, large stand-replacing fires on National Forest System lands can be a major source of greenhouse gas emissions and particulates. Increased wildfire activity can result in increases in particulate emissions, carbon monoxide, carbon dioxide, ammonia, and other pollutants from National Forest System lands. Changes in atmospheric circulation may lead to longer durations and more frequent periods of stagnant air, contributing to localized increases in adverse effects from criteria pollutants, such as ozone, particulate matter, and nitrogen oxides (Jacob and Winner 2009). Mercury occurs in the atmosphere at low concentrations and is deposited in surface waters and on vegetation and soils. The concentration of mercury is increased by biological activity, beginning with the activity of microorganisms in soils (U.S. EPA 2010). Increases in wildfire activity and the increased soil respiration due to higher temperatures can potentially release large amounts of mercury to the atmosphere (Wiedinmyer and Friedli 2007). Emissions from prescribed burning for all

alternatives are expected to be minor, and they would reduce overall emissions by reducing large wildfire risk.

The relative effects of climate change may vary slightly between the alternatives. Alternatives E-Modified Departure, E-Modified, and E include the most thinning and prescribed fire treatment proposals, which would create the most open canopy stands and would result in the greatest decrease in high severity fire. Alternatives D and F propose an intermediate amount of thinning and prescribed fire treatments followed by Alternatives A and B that each have slightly less, In the dry forest potential vegetation group, the fire regime condition class would improve the most at year 50 for Alternative D; Alternatives E, E-Modified, and E-Modified Departure each have values similar to alternative D. This improvement would reduce the risk of uncharacteristically severe wildfires the most and would also achieve the greatest reduction in risk of impacts on air quality and greenhouse gas emissions.

In the dry forest potential vegetation group, Alternatives A and C would have the most departed fire regime condition class at year 50 and would have the most uncharacteristically severe fires as a result. Being the most departed would result in the greatest impact on air quality and greenhouse gas emissions. For Alternative C, wildland fire would be used the most to achieve desired conditions, and thinning and prescribed fire treatments would be used the least to reduce the risk of uncharacteristically severe wildfire.

See the “Forest Vegetation,” “Timber and Forest Products,” and “Wildland Fire” sections in volume 2 for more information on climate change effects related to wildfire risk.

Watershed Function, Water Quality, and Water Uses

This section describes watershed, riparian, and stream channel conditions, water quality, water uses within the Malheur, Umatilla, and Wallowa-Whitman National Forests and the hydrologic and geomorphic characteristics of streams and rivers emanating from the national forests.

Changes Made Between the Draft and Final Environmental Impact Statements

Aside from changes described in the Preface to this document, the following changes have been made specifically to this section:

- **Reanalysis and Modeling of Forest Vegetation Forest:** Vegetation condition and departure from desired conditions were re-calculated. Details of the changes are described in the Forest Vegetation section of this document. The departure of forested vegetation is computed in 10-year time steps from year 0 (existing) to year 80. The data for years 0, 10, and 20 are used in this analysis to convey vegetation changes over the expected life of the plan. In the revised data, forest vegetation is separated into the three dominant forest potential vegetation groups (dry forest, cold forest, and moist forest), then divided into four management strata (general forest, wilderness, roadless, and reserve). The Vegetation Development Dynamics Tool (VDDT, ESSA Technologies Ltd. 2007) was used to model vegetation conditions in 10-year time steps. Vegetation condition was modeled for each combination of three dominant forest potential vegetation groups (dry forest, cold forest, most forest), and four management strata (wilderness, roadless, reserve, and general forest). Using assumptions of the distribution of vegetative treatments and disturbance frequencies, the future condition of forest vegetation in each alternative was determined in 10-year time

steps from year zero (existing condition) to year 80. Departure of forest vegetation from desired conditions was calculated for individual watersheds by summing the acres of each combination of potential vegetation group and management strata. Additional details are located in the “Forested Vegetation” and “Ecological Resilience” sections of this document.

- **Reanalysis of Watershed, Riparian and Stream Channel Conditions:** The revised vegetation data is incorporated into the assessment of hillslope, or terrestrial conditions within all watersheds, priority watersheds, and in key and priority watersheds combined. The reserve stratum is used as a surrogate for the condition of forested riparian areas. Detail has been added to the description of methods for determining watershed conditions. Data for livestock use, road miles, watershed areas, and road density have all been updated. Watershed-related restoration objectives are used to evaluate expected improvements in stream channel and riparian conditions. Subbasins, watersheds, and subwatersheds, when used in this analysis, refer to boundaries, names, and areas determined from the National Hydrography Dataset.
- **Key and Priority Watersheds:** The methods used to select key, priority watersheds, and tables listing key and priority watersheds are included in the 2018 Blue Mountains Aquatic and Riparian Conservation Strategy (2018 Blue Mountains ARCS; Appendix A of the Forest Plan). The list of key and priority watersheds has been updated since the Draft Environmental Impact Statement was released with additions for the Malheur National Forest and identification of watersheds selected as priorities for restoration under the Watershed Condition Framework.
- **Adjustments to Watersheds Analyzed:** Because multiple watersheds occur within the boundaries of more than one national forest, the tables in this section assign watersheds to the national forest in which the largest watershed area occurs. Watersheds with less than about 500 acres of National Forest System lands are excluded from the analysis. Watersheds located within the Hells Canyon National Recreation Area are not included in this analysis except in the discussion of cumulative effects.
- **Discussion of Hydrology and Stream Channel Conditions:** In response to public comment, discussions of hydrology and streamflow characteristics, channel morphology, and stream channel conditions have been added to the “Affected Environment” section and details have been added to the discussion of cumulative effects to hydrology, riparian habitats, and stream channel conditions.
- **Discussion of Climate Change:** The climate change discussion has been expanded to describe expected and potential changes in hydrology, watersheds, riparian habitats, and stream channel morphology and incorporate information from the “Blue Mountains Climate Change Vulnerability Assessment” (Halofsky and Peterson 2017).

Introduction

The watersheds, rivers, and streams of the Blue Mountains national forests in northeastern Oregon and southeastern Washington provide many ecological, economic, and social benefits. More than 30,000 miles of rivers and streams and 1,700 lakes and ponds support diverse communities of aquatic and terrestrial species, including salmon and steelhead. Tens of thousands of people rely on water from the national forests for drinking water, recreation, agriculture, industry, hydropower generation, and other uses.

This section describes the affected environment, existing conditions, and environmental consequences of the alternatives on watersheds, water quality, and water uses. Some of the effects on or arising from other resources, including soils, forested vegetation, wildfire, and livestock grazing, are mentioned in this section but are discussed in more detail in other sections. This section uses the terms subbasin, watershed, subwatershed, key watershed, and priority watershed. In some cases, the word watershed is used generically to denote the drainage area that contributes runoff to a common stream. Subwatersheds, watersheds, and subbasins are also known in the hydrological terminology currently used in the United States as successively larger hydrologic units. Hydrologic units are also denoted numerically. For example, the Lower John Day subbasin is a 4th-level subdivision of the Columbia River region and is denoted by an 8-digit hydrologic unit code, or HU 8, of 17070201 consisting of four 2-digit pairs of numbers. This hierarchy is illustrated in figure 25. Subwatersheds typically comprise areas of approximately 10,000 to 40,000 acres, watersheds have areas of about 40,000 to 250,000 acres, and subbasins have areas of greater than 450,000 acres. Key and priority watersheds, whenever the terms are used in this section, refer to subwatersheds as displayed in Table(s) 2, 3, and 4 of the 2018 Blue Mountains ARCS (Appendix A of the Forest Plan). Table 151 on page 333 lists the areas in acres of the basins and subbasins in the Blue Mountains national forests.

Setting

The climate of the Blue Mountains is largely continental with cold winters and hot, dry summers. Annual precipitation for the period from 1971 to 2000 ranged from less than 10 inches in low elevation valleys to more than 80 inches at the uppermost elevations in the Wallowa Mountains. The majority of precipitation falls as snow between October and April. Summers are usually dry and summer precipitation is associated with thunderstorm activity. The combined runoff of all rivers originating in the Blue Mountains totals about 7.4 million acre-feet per year, of which 5.2 million acre-feet (70 percent) originates in National Forest System lands (Table 152, page 334).

Fifty to 80 percent of runoff is derived from snowmelt and occurs in spring and summer. Spring runoff begins as early as late February at lower elevations and snowmelt runoff can continue into August in high elevation watersheds. Parts of the Blue Mountains that lie directly east of the Columbia River Gorge receive higher precipitation amounts from winter storms that are able to pass through the natural gap in the Cascade Range (Ferguson 1999).

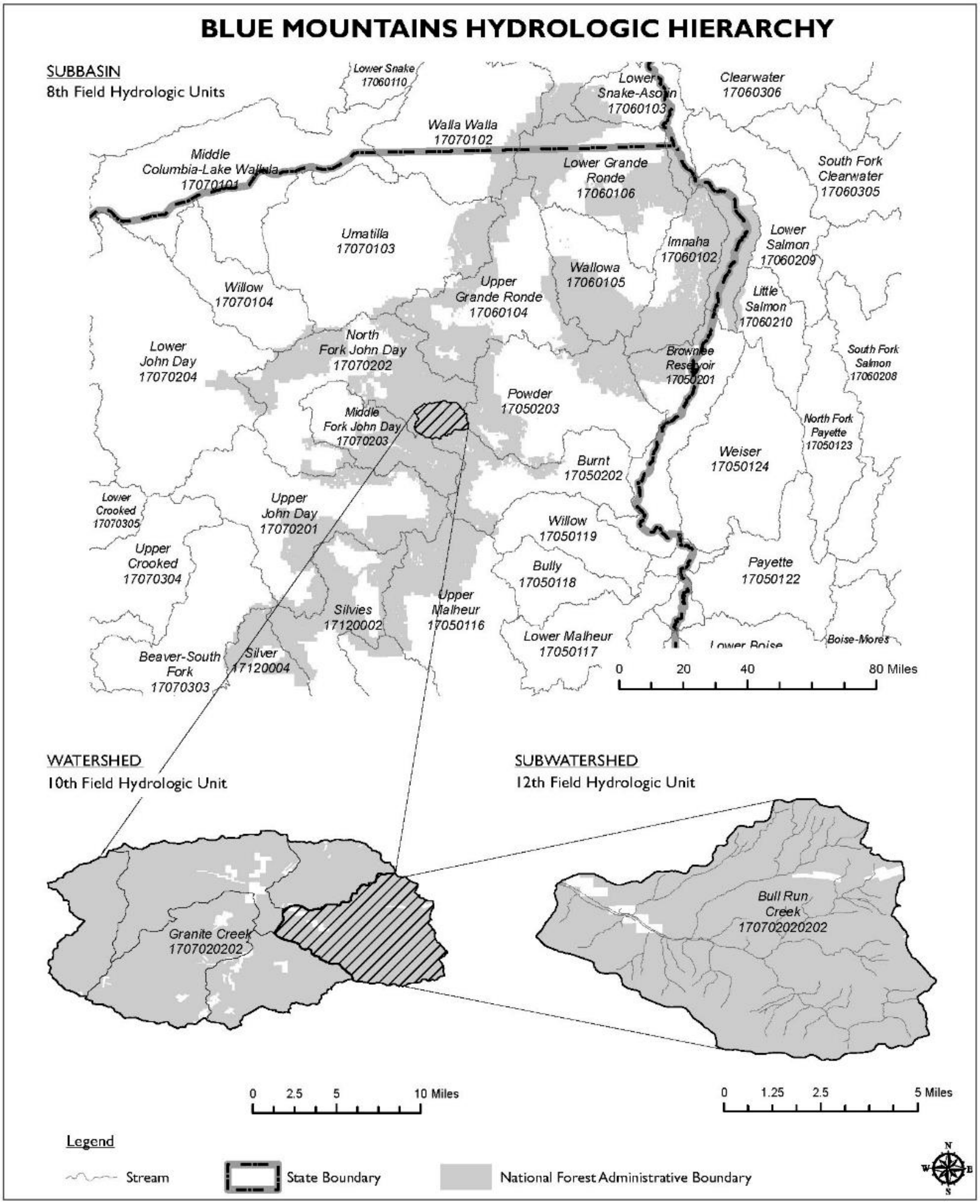


Figure 25. Hydrologic unit hierarchy: outlined areas are individual subbasins, cross-hatched polygon (top) is a watershed (Granite Creek) within the North Fork John Day subbasin: cross-hatched polygon (bottom) is a subwatershed (Bull Run Creek) within the Granite Creek Watershed

Table 151. Acres on the Malheur, Umatilla, and Wallow-Whitman National Forests and total National Forest System acres in each 4th-level watershed basin or subbasin

HU 8	Basin or Subbasin	Subbasin Area (acres)	Malheur (acres)	Umatilla (acres)	Wallowa-Whitman (acres)	Total NFS Area (acres)
17050116	Upper Malheur R	1,553,967	370,342	0	0	370,342
17050119	Willow – Snake	486,197	0	0	2,900	2,900
17050201	Brownlee	834,147	0	0	137,468	137,468
17050202	Burnt	703,512	0	0	199,494	199,494
17050203	Powder	1,093,330	0	0	355,148	355,148
17060101	Hells Canyon	346,521	0	0	252,167	252,167
17060102	Imnaha	544,438	0	0	384,396	384,396
17060103	Lower Snake - Asotin	450,287	0	63,122	47,220	110,342
17060104	Upper Grande Ronde	1,047,265	0	85,908	391,100	477,008
17060105	Wallowa	610,666	0	0	282,572	282,572
17060106	Lower Grande Ronde	971,747	0	252,894	234,208	487,102
17060107	Lower Snake - Tucannon	933,447	0	77,265	0	77,265
17060209	Lower Salmon*	755,356	0	0	212	212
17060210	Little Salmon*	369,142	0	0	8,240	8,240
17070102	Walla Walla	1,126,790	0	100,919	0	100,919
17070103	Umatilla	1,611,345	0	178,955	5,341	184,296
17070104	Willow	555,626	0	12,063	0	12,063
17070201	Upper John Day	1,368,978	427,376	0	0	427,376
17070202	North Fork John Day	1,182,939	0	564,996	89,780	654,776
17070203	Middle Fork John Day	506,976	270,494	20,820	0	291,314
17070204	Lower John Day	2,019,400	0	46,942	0	46,942
17120001	Harney-Malheur Lakes	948,213	46,791	0	0	46,791
17120002	Silvies River	813,847	388,742	0	0	388,742
17120004	Silver Creek	1,085,632	154,111	0	0	154,111
	TOTALS	20,309,073	1,657,856	1,403,884	2,378,894	5,440,634

HU 8 = 4th-level hydrologic unit code watershed; NFS = National Forest System; Acres for the Wallowa-Whitman National Forest include approximately 600,000 acres within the Hells Canyon National Recreation Area.

*Acres for the Wallowa-Whitman National Forest include approximately 600,000 acres within the Hells Canyon National Recreation Area.

Table 152. Estimated average annual streamflow, in acre-feet, by subbasin and national forest, for the period 1971-2000

HU 8	Basin or Subbasin	Annual Flow (acre-feet)	Malheur (acre-feet)	Umatilla (acre-feet)	Wallowa-Whitman (acre-feet)	National Forest Streamflow*	National Forest Area*
17050116	Upper Malheur	252,600	210,000	0	0	83%	24%
17050201	Brownlee	61,500	0	0	232,000	89%	16%
17050202	Burnt	167,000	0	0	56,000	34%	28%
17050203	Powder	578,000	0	0	400,300	69%	32%
17060101	Hells Canyon	344,200	0	0	344,000	NA	73%
17060102	Imnaha	418,000	0	0	371,600	89%	71%
17060103	Lower Snake - Asotin	150,000	0	120,600	9,400	87%	25%
17060104	Upper Grande Ronde	689,000	0	104,000	285,000	56%	46%
17060105	Wallowa	841,000	0	0	610,500	73%	46%
17060106	Lower Grande Ronde	750,000	0	610,000	101,000	95%	50%
17060107	Lower Snake - Tucannon	123,500	0	81,000	0	66%	8%
17070102	Walla Walla	415,100	0	271,000	0	65%	9%
17070103	Umatilla	424,000	0	300,000	0	71%	11%
17070104	Willow	22,500	0	2,500	0	11%	2%
17070201	Upper John Day	403,000	190,000	0	0	47%	31%
17070202	North Fork John Day	818,000	0	463,400	91,500	68%	55%
17070203	Middle Fork John Day	207,800	169,200	7,000	0	85%	57%
17070204	Lower John Day	265,000	0	5,300	0	2%	2%
17120001	Harney-Malheur Lakes	56,400	40,200	0	0	71%	5%
17120002	Silvies River	134,000	118,400	0	0	88%	48%
17120004	Silver Creek	56,800	40,200	0	0	71%	14%
	TOTALS	7,377,400	768,000	1,964,800	2,501,300	71%	27%

*The two right columns display the percentage of annual streamflow originating from within the National Forests for each subbasin and the percentage of area of each subbasin within the National Forests. Data compiled using methods and data from Cooper (2002) and flow data from U.S. Geological Survey and Oregon Department of Water Resources. The sum of runoff from the National Forest is approximately 5.2 million acre-feet per year (1971-2000 average).

Annual precipitation averages about 29 inches per year on National Forest System lands in the Blue Mountains. Annual precipitation averages about 22 inches per year on the Malheur National Forest, about 33 inches per year on the Umatilla National Forest, and 32 inches per year on the Wallowa-Whitman National Forest. Total precipitation in National Forest System lands amounts to about 13.5 million acre-feet per year, of which about 5.2 million acre-feet, or 38 percent, becomes streamflow. The ratio of runoff to precipitation varies from about seven percent in the Lower John Day subbasin to more than 64 percent in the Walla Walla subbasin, but may be higher or lower than this range in smaller watersheds. The amount of precipitation that contributes to groundwater recharge is largely unquantified, but is highest in areas of high precipitation that are underlain by Columbia River basalt and younger, volcanic, sedimentary, and alluvial aquifers (Gonthier 1985).

Watersheds in National Forest System lands in the Blue Mountains are distributed among 8 hydrologic basins and 25 hydrologic subbasins, and the amount of National Forest System lands varies by subbasin (see Table 151). All rivers and streams in the Blue Mountains are tributaries of the Snake River, the Columbia River, or the closed basins of east-central Oregon. Major tributary rivers originating in National Forest System lands in the Blue Mountains include the John Day, Umatilla, Malheur, Burnt, Powder, Imnaha, and Grande Ronde rivers in Oregon and the Tucannon and Walla Walla rivers and Asotin Creek in Washington. Silver Creek, Silvies River, and several smaller streams flow into the closed Harney-Malheur Lakes basin that is at the northwestern-most extent of the Great Basin. The headwaters of all of these streams are located in National Forest System lands.

National Forest System lands in the Blue Mountains comprise about 25 to 30 percent of the combined area of all subbasins and from 1 to 73 percent of the area of individual subbasins (see Table 152). Remaining lands include private lands, lands managed by state and Federal agencies, and American Indian reservations.

Land Use History

During the last 150 years, watershed and stream channel conditions in the Blue Mountains have been altered by a series of human uses, including mining, logging, agriculture, water diversions, stream channelization, flood control, wildfire exclusion, livestock grazing, road construction and maintenance, and hydro-electric development (McIntosh et al. 1994). The combined impacts of past land uses include, but are not limited to changes in vegetative conditions, simplification and loss of aquatic habitats, increases in sediment delivery to streams, and degradation of riparian and floodplain functions (McIntosh et al. 1994, Wissmar 2004). The timing and intensity of land use effects varies across individual river basins and is punctuated by natural disturbances, including fires and floods that can result in unique combinations of disturbance histories and responses in each basin. In general, the resulting degradation and fragmentation of aquatic and riparian habitats and impacts to water quality contributed to declines or extirpation of many resident and anadromous fish stocks, the listing of several fish stocks under the Endangered Species Act, and the listing of many streams as water quality impaired beginning in the early 1990s.

Recent Past

PACFISH (USDA and USDI 1995) and INFISH (USDA Forest Service 1995) were implemented in response to the potential listing under the Endangered Species Act of several anadromous and resident fish species in the Snake River and interior portions of the Columbia River basin and

included measures that were intended to halt further degradation of the habitats of these species on Federal lands. Both strategies include:

- designation of riparian habitat conservation areas to be managed for the benefit of aquatic- and riparian-dependent species;
- identification of and increased protection of watersheds supporting listed species in good condition or that could be restored;
- standards and guidelines intended to modify or limit adverse effects of land management activities; and
- monitoring.

Existing forest plans were amended by PACFISH and INFISH in 1995. Subsequent biological opinions by the National Marine Fisheries Service (NMFS 1995, 1998) and U.S. Fish and Wildlife Service (1998) specified additional requirements for the protection and restoration of aquatic and riparian habitats in National Forest System and Bureau of Land Management lands, including the development and implementation of an area-wide monitoring strategy (PACFISH and INFISH Biological Opinion, Kershner et al. 2004) to track the effects of implementing the two strategies, the development of a regionwide watershed and aquatic restoration strategy (USDA Forest Service 2005), and an analysis of the effects of forest roads (Road Density Analysis Team 2002).

PACFISH and INFISH both specified watershed analysis as a necessary tool for identifying desired conditions and restoration opportunities but did not include formal guidance for watershed and aquatic habitat restoration.

PACFISH and INFISH were intended as interim strategies that were expected to be replaced upon finalization of the Interior Columbia Basin Ecosystem Management Project (ICBEMP) (Quigley et al. 1997). The Interior Columbia Basin Project was expected to provide the long-term strategy used on Federal lands in the interior Columbia River basin. In 2001, Regional Directors of the Bureau of Land Management and Regional Foresters of the U.S. Forest Service decided not to prepare a Record of Decision, choosing instead to complete the Interior Columbia Basin Project through implementation of “The Interior Columbia Basin Strategy.” The strategy addresses concerns raised by the public, incorporates the scientific data and findings of the analysis, and makes recommendations for inclusion in revised forest plans.

Subsequently, the Forest Service developed the Aquatic and Riparian Conservation Strategy (USDA Forest Service 2008) as guidance intended to provide a regionally consistent approach to the management of watersheds and riparian and aquatic habitats. The rationale for the 2008 Strategy was based on lessons learned from 15 years of successful implementation of PACFISH, INFISH, and the Northwest Forest Plan (Reeves 2006).

In 2016, the Regional Aquatic and Riparian Conservation Strategy was updated to provide consistency with national agency planning direction, and to revise and clarify specific components of the strategy. The 2008 Aquatic and Riparian Conservation Strategy is applied to Alternatives, B, C, D, E, and F; the 2018 Blue Mountains Aquatic and Riparian Conservation Strategy is based on the 2016 Regional ARCS and contains additional desired conditions, standards, and guidelines that are specific to the Blue Mountains. The 2018 Blue Mountains ARCS is incorporated into two additional alternatives that are modifications of Alternative E: Alternative E-Modified (the preferred Alternative) and Alternative E-Modified Departure. PACFISH and INFISH, and the development of the 2018 Blue Mountains Aquatic and Riparian

Conservation Strategy are discussed in more detail in the "Aquatics Species, Diversity and Viability" section, and in lesser detail in this section. The 2018 Blue Mountains ARCS for the revised forest plans is included as Appendix A in each Forest Plan.

The Pacific Northwest Region of the Forest Service developed guidance for aquatic habitat restoration on National Forest System lands in 2005. The regional Aquatic Restoration Strategy (referred to as the 2005 Regional ARS) prioritized river basins and watersheds for the purposes of investing in the most critical areas and completing whole watershed restoration (USDA Forest Service 2005).

In 2011, the Watershed Condition Framework (WCF, USDA Forest Service 2011a) was implemented on all national forests as a means of determining watershed conditions, assessing the change in watershed conditions over time, prioritizing watersheds for restoration, and tracking restoration accomplishments. Use of the Watershed Condition Framework is incorporated into Alternatives E-Modified and E-Modified Departure. Components of the Watershed Condition Framework are described in the Blue Mountains ARCS (Forest Plan, Appendix A), USDA Forest Service (2011) and Potyondy and Geier (2011). Alternatives, B, C, D, E, and F would incorporate elements of the 2008 Regional ARCS.

Community-based Watershed Restoration

In the early 1990s, the Northwest Power Planning Council selected several watersheds in the Blue Mountains with high fisheries values, including the Asotin, Pataha, Tucannon, and Grande Ronde watersheds to support and promote cooperative restoration. These four watersheds were named as "model" watersheds with the intent of promoting collaborative partnerships in determining restoration goals and implementing watershed restoration. Watershed Councils exist in all subbasins that are tributary to the Snake and Columbia Rivers and provide a basis for collaboration between the national forests, other local, state, and Federal agencies, Tribes, and local communities interested in watershed, riparian, and aquatic habitat restoration.

Three American Indian treaty Tribes, the Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, and Confederated Tribes of the Warm Springs Indian Reservation, have been major sponsors of watershed and aquatic habitat restoration on ceded lands in the Blue Mountains for decades. The Oregon Watershed Enhancement Board, a state agency, provides grants to help Oregonians care for local streams, rivers, wetlands and natural areas. In 1999, the Washington state legislature created the Salmon Funding Recovery Board to provide funding for elements to support overall salmon recovery and other activities that benefit salmon. The Forest Service has joined in community-based partnerships through these and other programs and has cooperators in every subbasin in the Blue Mountains.

Of the 25 subbasins displayed in Table 151, the National Forests in the Blue Mountains manage roughly 25 percent of the land base, including lands managed by the Ochoco National Forest in the Lower John Day and South Fork Crooked subbasins. Remaining lands include lands owned or managed by the Bureau of Land Management, Tribes, State lands, and private lands.

Watershed Function, Water Quality, and Water Uses – Affected Environment

This analysis includes an assessment of watershed conditions in approximately 500 subwatersheds located in 22 river basins displayed in Figure 25 and listed in Table 151.

Watersheds with less than about 500 acres of National Forest System lands are omitted from parts of the analysis, which reduces the number of watersheds assessed for this analysis to about 440. Watershed condition is described in terms of its component parts, described here as hydrologic function, stream channel function, riparian and wetland function, and water quality. Soils are partially addressed here as part of hydrologic function and cumulative effects, but are addressed in more detail elsewhere in this document. Aquatic habitat is considered a component of watershed condition but is also addressed separately in this document.

Key indicators for watershed function used in this analysis are:

- Upslope conditions within watersheds based on changes in forested vegetation condition, hydrological connectivity of the road system, and grazing use intensity
- Grazing influence on riparian habitats
- The extent of riparian habitat conservation areas or riparian management areas
- Riparian, stream channel, and aquatic habitat restoration (miles and acres)
- Detrimental soil conditions resulting from timber harvest
- Changes in overall watershed conditions
- Change in the condition of Priority Watersheds

Indicators for water quality include all of the previous items in addition to objectives for:

- Water quality restoration plans implemented

Watershed Function

Naiman et al. (1992) described the fundamental components of ecologically healthy watersheds as basin geomorphology, hydrologic pattern, water quality, riparian forest characteristics, and habitat characteristics and proposed that ecologically healthy watersheds require preservation of the interactions between these components as well as the spatial and temporal variability of system components. Following Naiman et al. (1992), watershed function, as used in this analysis, includes: watershed, hydrologic, riparian, wetland water quality, stream channel, and aquatic habitat conditions, and the processes that create and maintain them. The role of riparian forest described by Naiman et al. (1992) is extended to riparian areas in general (Gregory et al. 1991), whether they are forested or non-forested. Some aspects of watershed-related functions or conditions are also discussed in the following sections of this document:

- “Livestock Grazing and Grazing Land Vegetation”
- “Aquatic Species Diversity and Viability”
- “Plant Species Diversity and Threatened, Endangered, and Sensitive Plants”
- “Soils”

The components of watershed function, as described in this section, all have influence on the diversity and viability of aquatic species as described in the “Aquatic Species Diversity and Viability” section. Watershed function also relates to water quality and water uses as discussed in this section.

Watershed conditions in the Blue Mountains were assessed in the Draft Environmental Impact Statement using a model based on the Ecosystem Management Decision Support System (EMDS; Reynolds 1996, 1999). In this analysis the original model structure is retained, but modeled conditions are calculated numerically and the EMDS is not used. Some analytical power is lost in

this conversion, but the intent in this analysis is to compare the relative strength of the alternatives at improving or restoring watershed conditions. Model assumptions and methods are described in detail in Reiss et al. (2008) and deviations from those methods are described in this section. The basic approach uses detailed analysis of watershed, riparian, stream channel, and aquatic habitat attributes. Assessment of the state of these attributes is used to define the condition of the approximately 440 subwatersheds containing more than 500 acres of National Forest System lands in the Blue Mountains.

Watershed condition is treated as a combination of stream channel, riparian, and hillslope conditions (Figure 26). Stream channel data is taken from local stream survey data for the period 1989-2006. Data for the period 1996-2006 is used preferentially because the methods for describing large wood frequency and bank stability in older surveys are different and not comparable to recent data. Older data, for the period 1989-1995, is used for watersheds in which recent data is unavailable. While use of older data might mask changes in condition over time, available data suggests that the difference between managed and reference conditions is large for most channel attributes and that this difference remains for many attributes, even after accounting for trend in condition. The attributes used in the 1989-1995 data (stream shade, residual pool depth, riparian shrub abundance, and pool spacing) were weighted so that the distributions of scores for channel data from the 1989-1995 and 1996-2006 periods were equal. Data for the older period was used because recent surveys provide data for less than 20 percent of watersheds in the analysis area, and use of older data is assumed to be a reasonable representation of channel conditions for the purpose of this analysis.

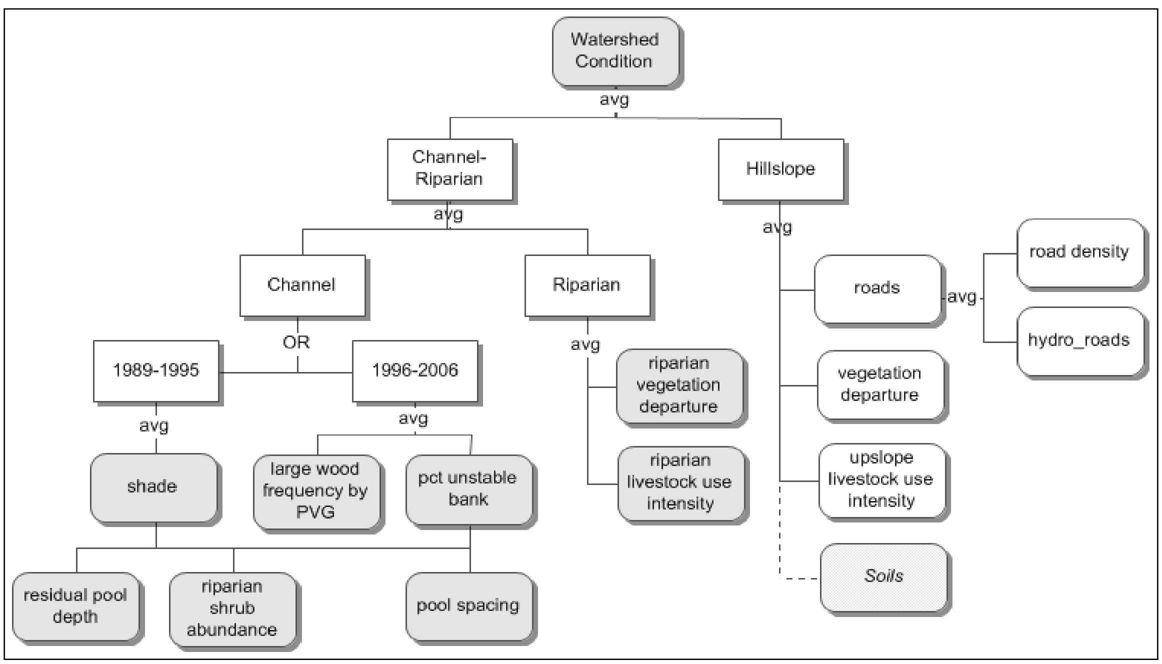


Figure 26. Model structure for assessing watershed conditions[24]

[24] For each attribute, upper and lower node values representing good (+1) and poor (-1) condition are set based on available literature and professional judgement. Values for each metric between defined upper and lower node values are calculated by linear interpolation. Attributes used to assess channel, riparian, and hillslope conditions are equally weighted. Scores for attributes used to calculate channel, riparian, and stream channel condition are each averaged,

Modeled condition scores for individual attributes each range from +1 to -1, where the scores are intended to reflect the relative strength of evidence for the proposition of good condition (Reynolds 2006). For this analysis, scores are bracketed into thirds, with scores ranging from +0.33 to +1, representing good condition, scores from +0.33 to -0.33 representing intermediate conditions, and scores from -0.33 to -1 representing poor conditions. These classes are intended to be analogous to condition classes 1 (functioning properly), 2 (functioning at risk), and 3 (impaired) used in the watershed condition framework (USDA Forest Service 2011a). Based on channel and riparian conditions alone, the data used in this analysis suggests that conditions in 81 percent of watersheds are in fair, or functioning at risk, condition, 10 percent in poor, or impaired condition, and less than 9 percent in good, (or functioning properly, condition. Methods and analysis assumptions are described throughout this section.

Impacts to riparian and aquatic habitats in the Blue Mountains increased rapidly following European settlement of the region (after 1850). Mining, agriculture, splash dams, floodplain alteration, channelization, logging, and livestock grazing each have had substantial impacts on streams in the Blue Mountains (McIntosh et al. 1994, Wissmar et al. 1994, Wissmar 2004). Of these activities, reaches where splash dams and log drives are known to have occurred stand out as having wider, shallower channels (and greater width-to-depth ratio), coarse substrate and lack of spawning gravel, lack of large woody debris, reduced channel complexity, and lower quality habitat.

Work by McIntosh (1992) and McIntosh et al. (1995) documents the decline in the quality and frequency of pool habitat and reduced frequency of large wood in streams in the Columbia Basin between the 1930s and 1980s. McIntosh et al. (1994) and McIntosh (1995) showed that pool and large wood frequency declined in managed rivers in the Blue Mountains but increased in unmanaged (wilderness) watersheds during the same time period. Evaluation of aquatic habitat conditions has the highest level of uncertainty in this analysis because of the variability observed in the data and the influence this has on choosing reference conditions. Considering channel features alone, model results indicate more subwatersheds with poor habitat conditions (106, 25 percent) than good condition subwatersheds (5, 1 percent), and most watersheds (313, 74 percent) display a midrange of habitat condition, although one or more individual features may exert more influence on existing condition.

Model results for overall existing watershed conditions place 59 of 428 subwatersheds in good condition (14 percent), 264 in fair condition (62 percent), and 105 in poor condition (25 percent).

Hydrologic Function

Hydrologic function involves all of the processes involved in the conversion of precipitation to streamflow within watersheds. This includes the routing of water, sediment, and nutrients from hillslopes through the channel network and the interaction of physical, chemical, and biological processes (Naiman et al. 1992). Key influences on the hydrologic functioning of forest and rangeland watersheds include the condition and type of vegetation, ground cover, soil properties and conditions, and the nature and condition of riparian vegetation, all of which the affect rates of material inputs to streams, and the rate of watershed runoff. For illustration, Table 153 displays mean annual precipitation and streamflow for each national forest. The difference between

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then resulting scores for channel and riparian condition are averaged together, then the resulting channel-riparian and hillslope scores are averaged to obtain watershed condition.

precipitation and streamflow is displayed as evapotranspiration (ET) but is more correctly defined as ET plus an unknown, but typically much smaller quantity of water that becomes groundwater.

Table 153. Average annual precipitation in inches and acre-feet, streamflow in acre-feet, and evapotranspiration (ET) for each national forest

Forest	Precipitation (inches)	Precipitation (acre-feet)	Streamflow (acre-feet [%])	Evapotranspiration (ET) + Groundwater (acre-feet [%])
Malheur	22.1	3,151,000	768,000 [24%]	2,383,000 [76%]
Umatilla	33.2	3,888,000	1,965,000 [51%]	1,923,000 [49%]
Wallowa-Whitman	32.2	6,424,000	2,500,000 [39%]	3,923,000 [61%]
Total/avg	29.3	13,463,000	5,234,000 [39%]	8,229,000 [61%]

Table 153 displays that the second largest component of the forest water budget after precipitation is water that is evaporated or transpired back to the atmosphere. Because evaporation and transpiration are difficult to quantify separately, they are usually combined into a single term (ET). The magnitude of evapotranspiration underscores the role of vegetation in the functioning of watersheds. Averaged over the area all three forests, evapotranspiration is the equivalent of 17.9 inches per year while actual streamflow equates to 11.4 inches per year.

Of more than 30,000 miles of rivers and streams in the Blue Mountains national forests, about 9,000 miles (30 percent) are perennial (flow year round; see Table 154). These streams provide habitat for diverse communities of vegetation, wildlife, anadromous and resident fish, and provide water for downstream uses that include crop irrigation, domestic livestock, municipal and domestic water supplies, hydropower generation, commercial, industrial, and other uses. Other important water resources in National Forest System lands include lakes and ponds, reservoirs, and springs and seeps, which provide important habitats for a variety of plant and animal species and are the source areas of many streams that support downstream uses (see Table 155 through Table 157).

Table 154. Summary of stream miles in National Forest System lands (from national hydrographic dataset (NHD) flowline)

National Forest	Intermittent Streams	Perennial Streams	Totals
Malheur	2,983	2,593	5,576
Umatilla	4,999	2,259	7,258
Wallowa-Whitman	13,151	4,394	17,544
Totals	**21,113 (70%)**	**9,245 (30%)**	**30,378 (100%)**

Table 155. Other water resources within the Malheur National Forest (from NHD)

Water Resource Type	Quantity	Acres
Lakes and ponds	498	308
Reservoirs	3	3
Swamp/marsh	16	42
Springs and seeps	2,851	NA

Table 156. Other water resources within the Umatilla National Forest (from NHD)

Water Resource Type	Quantity	Acres
Lakes and ponds	515	390
Reservoirs	31	6
Swamp/marsh	31	181
Springs and seeps	641	NA

Table 157. Other water resources within the Wallowa-Whitman National Forest (from NHD)

Water Resource Type	Quantity	Acres
Lakes and ponds	638	3,847
Reservoirs	77	26
Swamp/marsh	410	1,211
Springs and seeps	1,193	NA

Streamflow Characteristics

Streams in the Blue Mountains are considered snowmelt dominated but vary in the volume of runoff due to melting snow (Figure 27). The majority of annual precipitation occurs between October and April. In fall and spring, precipitation may fall as rain at lower elevations but occurs as snow at higher elevations. In the three coldest months, December through February, precipitation usually falls as snow at all elevations. Weather records for sites in the Blue Mountains indicate that, on average 50 to 75 percent of precipitation occurs from October to April, 80 to 90 percent occurs from October through June, and on average, only 10 to 20 percent of annual precipitation occurs in July, August, and September.

In the graphs shown, site names are U.S. Geological Survey gage locations. Arrows show approximate periods of snowmelt. Differences in hydrograph shape show relative influences of snowmelt magnitude and timing versus rainfall. At high elevations, the majority of runoff occurs from late March to early July in response to melting snow, and peaks near end of May. At mid-elevations most runoff is late February to end of June, peaks near the beginning of May, and December and January flows are slightly elevated and variable due to episodic rain events. At low elevations streamflow is elevated from November through February by rainfall, and from March through June by snowmelt. Winter streamflow is highly variable, and snowmelt runoff in April and May is less pronounced than from higher elevation watersheds. Elevated base flows in the South Fork are likely due to groundwater influence specific to this watershed.

Accumulated snowpack begins to melt in response to warming temperatures in spring months. Spring runoff often begins in February at lower elevations sites and can extend through August at high elevation sites. Two-thirds of annual peaks (the highest recorded flow at a site in single water year) occur between March and July, with timing dependent on elevation and varying from year to year.

Runoff volume in the Blue Mountains is highest in April and May at most gaged streams, and in May in June from high elevation watersheds. Lowest streamflow typically occurs in August and September and occasionally in October, but low flows on Strawberry Creek, a high elevation watershed, occur in October through March and this is presumed to be due to freezing temperatures in late fall and winter.

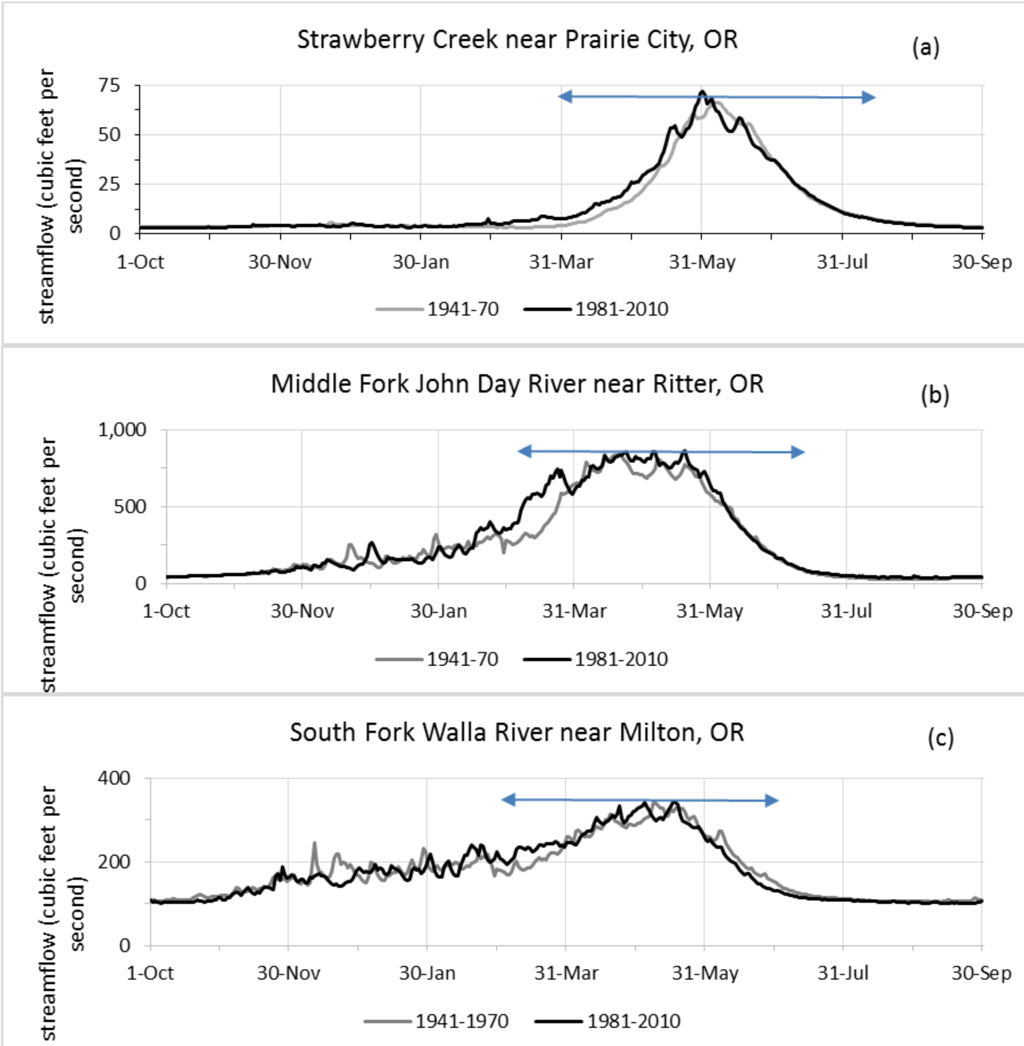

Figure 27. Hydrographs of mean daily streamflow by water year (October 1 to September 30), averaged for the periods 1941-1970 and 1981-2010, for high elevation (Strawberry Creek), mid-elevation (Middle Fork John Day River), and low elevation (South Fork Walla Walla River) sites in the Blue Mountains

Based on the records of 30 stream gage sites in the ten main river basins in the Blue Mountains for the years 1951-2008:

- 716 of 1347 (53 percent) recorded peaks occurred in spring (March, April, May for the purpose of this analysis),
- 186 occurred in summer (June, July, August),
- 1 percent occurred in fall (September, October, November), and
- 431 (32 percent) occurred in winter (December, January or February).

The timing of peak flows varies with elevation of individual gage sites and the elevation of the watershed above each site. For example, at Strawberry Creek near Prairie City, all 85 annual peaks have occurred from late April to the first week of July (average date May-28). On the Grande Ronde River at La Grande, 62 of 80 recorded peaks occurred March, April, May or June, and 18 peaks have occurred in December, January, or February (average date March 21). At Mill

Creek near Walla Walla, the average peak date is February 6, 71 percent of annual peaks occur in the months of November through February, and only 28 percent of annual peaks have occurred in the months of March through June.

The mechanisms of peak flows in the Blue Mountains vary. December, January and February are the coldest months of the year, but peak flows in these months are rain events, and occur as either rain on snow or rain on frozen ground (Cooper 2006, Waananen et al. 1971). Spring and early summer peak flows are dominated by snow melt, but rain during these months is common and spring peaks are often augmented by rainfall. For example, 32 of 40 spring peaks between 1949 and 1988 on the Grande Ronde River at La Grande occurred on days of measurable rainfall at La Grande. Later spring peak flows are more likely to occur on days of high temperature, or following periods of rapid warming.

Winter peaks flows on rivers in the Blue Mountains are not uncommon, but are most frequent at low elevation sites surrounding the Blue Mountains, are less common at mid-elevation sites, and rare or absent at sites draining the highest elevation watersheds in the Wallowa, Elkhorn, and Strawberry mountains. Most mid-winter storms approach the Pacific Northwest from the west or northwest and produce snow in eastern Oregon. However, some storms from the southwest draw warmer air and moisture from low latitudes. A subset of these storms, and the storms responsible for the majority of winter floods in the Blue Mountains are a class of storms called “atmospheric rivers” by Zhu and Newell (1998), and more popularly known as pineapple express events. Atmospheric rivers were so named because they appear as long and relatively narrow plumes of moisture, 150-300 miles wide and up to 2,000 or more miles long. The amount of water vapor that they transport can be the equivalent of the flow of the Amazon River and the strongest storms carry 7-15 times the average flow of the Mississippi River at speeds 30 miles per hour or more. Atmospheric rivers occur in all oceans, are responsible for up to 90 percent global water vapor transport between the tropics on the poles, and 30 to 50 percent of precipitation along the west coast of the United States.

Most atmospheric river storms last for less than a day over a given area, but they can last for several days, and individual storms may arrive in sequences that can persist for several days or more. Because the low pressure systems that drive atmospheric rivers are moving, it is possible for a single atmospheric river to sweep across the entire length of the west coast of the United States. Rainfall intensity varies but is highest in parts of the Pacific Coast with the steepest topography. Rainfall totals of the strongest storms can be roughly equivalent to rainfall resulting from hurricanes in the eastern U.S. Rainfall intensity in eastern Oregon and Washington is moderated by the barrier effect of the Cascade Range, but atmospheric rivers have still produced some of the largest floods on record in the Blue Mountains.

Because atmospheric rivers draw air and water vapor from low latitudes, they tend to be warmer than other storms and it is not unusual for temperatures to rise 4 to 8 degrees Fahrenheit, or for freezing levels rise by 2,500 feet or more. During 18 atmospheric river events at La Grande, Oregon, average daily temperatures on the dates of peak flows averaged 8 degrees warmer than for the three days prior to the flood, and in one case were as much as 35 degrees warmer than before the storm (pre-storm temperature was below zero).

A reconstruction of the dates of atmospheric rivers occurring from 1951-2008 by Dettinger (2011) and comparison to streamflow records in the Blue Mountains shows that 83 percent of winter peaks have occurred within 1 to 3 days of land-falling atmospheric rivers on the coasts of Oregon and northern California. On the Grande Ronde River, all 13 winter peaks and 5 spring peaks since

1950 are associated with atmospheric rivers, including the flood of record in January 1965. Floods in December 1964, January 1965, February 1986, February 1996, January 1997, and November 2006 were all the result of atmospheric rivers and one of these floods is among the 10 highest floods of record on many of the gage sites in the Blue Mountains. Floods on Pine Creek on the Wallowa-Whitman national forest, in June 2012 were also related to an atmospheric river. Atmospheric rivers vary in strength and not all result in floods. An estimated 30% of annual precipitation in northeast Oregon results from only a few atmospheric river events each year. Precipitation from atmospheric rivers may be in the form of snow at high elevation. Guan et al. (2010) estimated that 40% of annual snow water equivalent during the years 2004-2010 accumulated during 5 to 7 atmospheric river events per year. Similarly, 18 of the 20 highest total runoff years on Strawberry Creek, and 9 of the 19 highest spring peaks occurred following winters that averaged 5-6 atmospheric river storms.

Riparian and Wetland Function

Riparian and wetland areas provide critical habitat for many terrestrial and aquatic species and important links between upland and stream habitats. Riparian areas occur within a zone of interaction between surface and groundwater, between the river and its floodplain, or between headwater streams and adjacent hillslopes (Stanford 1998).

Riparian habitats and riverine wetlands in the Blue Mountains are composed of more than 180 distinct plant associations (Crowe and Clausnitzer 1997, Wells 2006) and occupy about 21,000 acres (1 percent) of National Forest System lands in the Blue Mountains, according to National Wetland Inventories for Oregon and Washington (USFWS 2010). Off-channel wetlands, many fed by isolated springs or groundwater, occur in a variety of settings and occupy an additional 31,400 acres of National Forest System lands (USFWS 2010). Springs, rivers, lakes, wetlands, floodplains, and the riparian vegetation along streams may all interact with groundwater or are groundwater-dependent (Dwire and Mellmann-Brown 2017). More detailed descriptions of wetlands and groundwater-fed ecosystems is contained in the “Plant Species Diversity” section of this document.

The acres of riparian and wetland habitats displayed on maps produced by the National Wetland Inventory are displayed in Table 158. The area of riparian vegetation within the Blue Mountains is estimated to be about 2 to 3 percent of total land area, or 110,000 to 165,000 acres (Hann et al. 1997), so it is likely that the National Wetland Inventories maps under-represent the area of riparian habitats by as much as 140,000 acres for the three National Forests.

Table 158. Riparian and wetland acres for each national forest

Wetland Type	Malheur	Umatilla	Wallowa-Whitman	Totals
Riverine (riparian) wetlands	4,850	5,290	10,880	**21,015**
Lacustrine and palustrine wetlands	11,400 (4,439 sites)	6,890 (3,190 sites)	13,140 (5,500 sites)	**31,430 (13,129 sites)**
Total wetland areas[1]	16,360	12,260	24,280	**52,890**

1. Total area includes small areas of unclassified wetland types. Source is National Wetlands Inventory. Areas subject to verification.

Riparian vegetation performs several key functions for stream ecosystems, including the provision of shade, bank stability, nutrient transfer, retention of organic material, and the supply of woody material (Gregory et al. 1989, 1991). The functions provided by riparian vegetation may vary with stream size, floodplain width, channel gradient, watershed topography, the nature of the flow regime, and the species composition of near-stream vegetation. Because riparian species vary in their establishment mechanisms, water requirements, and tolerance to inundation (Everitt 1968; Mahoney and Rood 1998; Johnson 2000; Nilsson and Svedmark 2002), differences in channel and floodplain morphology result in high spatial and temporal variability in species composition and age class structure within and along riparian zones (Naiman 2000; Naiman et al. 2000; Hupp and Osterkamp 1985; Karrenberg et al. 2002; Kovalchik and Chitwood 1990; Scott and others 1996; Bendix and Hupp 2000).

Conifers are more common in riparian zones of steeper, confined and moderately confined valleys in which valley floor width is only a few times wider than the stream channel. Streamside forests are sources of large wood to streams that contributes to pool formation, dissipates stream energy, slows sediment transport, and provides channel stability (Montgomery et al. 1995). Even though 80 to 90 percent of the national forests are occupied by one of three dominant potential vegetation groups (dry forest, moist forest, or cold forest), available stream survey data suggests that as much half of perennial streams are bordered by at least a riparian fringe in which the dominant vegetation is something other than trees. However, less than 20 percent of low gradient stream reaches in the Blue Mountains used to monitor the effectiveness of PACFISH and INFISH are classed as non-forested for the purpose of this analysis, and less than 10 percent of reference sites in the Columbia River Basin are non-forested reaches. The zone occupied by riparian-dependent species could be only a few feet wide or up to several hundred feet wide depending on local topography and valley width and typically consists of deep-rooted herbaceous species (sedges), shrubs (willow, dogwood), or trees (cottonwood, aspen, alder).

In the Blue Mountains, non-forested riparian areas are more common in wider valleys in which the valley bottom width is several times higher than channel width and the valley bottom is flooded for a few days to several weeks each year. Vegetation consists of riparian shrubs (willow, dogwood, birch) in combination with herbaceous species that provide high bank stability. Prior to European settlement, shrub dominated riparian zones were likely also beaver complexes in which organic material in beaver dams provided most or all of the same functions as large wood in steeper, forested, headwater streams (Pollock 2003).

Of interest in this analysis are that riparian forests in the Blue Mountains were among the first to be logged, were historically preferred sites for grazing of livestock, were sites of extensive placer mining in certain river basins, and are more likely to have roads, among other impacts. Riparian habitat characteristics in headwater streams develop in response to disturbances such as fire, floods, debris flows, and the inherent variability of the flow regime. Changes in any of these factors can alter riparian conditions, with resulting effects on channel morphology. The combined effect of past land use in the Blue Mountains, from at least the late 1800s to the present has been an overall reduction in the extent of riparian habitats, decline in riparian and aquatic habitat conditions, changes in stream channel conditions, and reduced water quality.

Stream Channel Function and Channel Morphology

About 31,000 stream miles, including 9,000 miles of perennial streams occur within the three national forests. Variations in geology, tectonic history, topography, precipitation, temperature, and vegetation, result in the development of channel networks with differing suites of disturbance

processes, channel morphologies, and distributions of channel types. Montgomery and Buffington (1993, 1997) broadly categorized streams using the relative difference between the ratio of sediment supply to sediment transport capacity into source, transport, and response reaches. Source segments occur in steep (greater than 20 percent slope) headwater areas where sediment accumulates in mostly un-channeled swales and where flow duration and volume have limited ability to mobilize sediment except during episodic failures such as during debris flows. Transport reaches are high gradient streams (greater than 3 percent) with the ability to rapidly convey sediment loads (transport capacity greatly exceeds sediment supply). Low gradient streams have low transport capacity relative to sediment supply and may have prolonged responses to changes in streamflow or sediment supply that result in changes in channel morphology. For this reason, response reaches are more sensitive to the effects of land management and disturbance (Montgomery and Buffington 1993, 1997) and this is part of the rationale for their inclusion in the PACFISH-INFISH Biological Opinion effectiveness monitoring network (Kershner et al. 2003).

Montgomery and Buffington (1997) identify five alluvial channel types: cascade, step pool, plane bed, pool-riffle, and dune ripple in addition to forced morphologies and further recognize intermediate channel types. Large woody material can induce pool formation in steeper reaches (forced step pool) and moderate gradient reaches (forced pool riffle). Removal or loss of large wood from forested streams can induce an opposite change, for example by the conversion of forced pool riffle streams to plane bed streams (Montgomery et al. 1995). In Montgomery and Buffington's classification, differences in valley constraint, gradient and sediment supply result in stream reaches with different hydraulic and sediment transport characteristics that result in distinct channel morphologies that vary from upstream to downstream in individual watersheds. Differences in geology, topography, and climatic factors can be used to divide channel networks into discrete regions with distinctly different disturbance regimes and different distributions of channel types (Montgomery 1999). Montgomery (2002) used this concept to describe differences between glaciated and non-glaciated valleys. Polvi et al. (2011) noted that these differences affect the species composition and distribution of riparian types in glacial and fluvial valleys; Livers and Wohl (2015) noted differences in channel morphology between glaciated and non-glaciated valleys in the Colorado Front Range. A review of data from reference PIBO sites indicates significant differences in nearly all channel attributes between sites in glaciated valleys and non-glaciated (fluvial) valleys, suggesting that these differences should be recognized when using reference sites to determine desired (or possible) channel attributes for managed streams.

Montgomery and Buffington note that given channel types are "most likely" to occur within certain ranges of channel slope, but that channel types often overlap slope breaks, and further that similar channel types may have different characteristic ranges of slope in different river basins.

Rosgen (1994, 1996) classified streams into A, B, C, D, E, F, and G channel types. Rosgen A channel types correspond to cascade channel and step pool types in Montgomery and Buffington's classification. Rosgen B channels may by step pool, plane bed, or an intermediate channel type (riffle bar, Montgomery and Buffington 1997; riffle run, Livers and Wohl 2015). Rosgen C and E channels are equivalent to pool riffle streams in the Montgomery and Buffington classification. There is not a strict one-to-one correspondence between the two classifications (Buffington 2013) and the two classifications have some differences in the channel types that each includes.

Of interest in this analysis is that different channel types have different characteristic morphologies, and that disturbance can lead to a number of possible responses, including changes

from one channel type to another. Following implementation of PACFISH and INFISH, a network of several hundred monitoring sites was established in order to assess the effectiveness of Federal land management in protecting aquatic species in the Columbia River basin. Collectively, these sites are referred to as the PACFISH-INFISH Biological Opinion effectiveness monitoring sites. After Montgomery and Buffington (1993), the monitoring originally selected reaches with gradients less than 3 percent with the rationale that these reaches were most likely to "respond" to the effects of land management. There are more than 300 managed PACFISH-INFISH Biological Opinion monitoring sites in the Blue Mountains and about 260 reference sites in the Columbia and Missouri River basins, including 19 sites in the Blue Mountains. Classification of these sites using Montgomery and Buffington's (1997) criteria results in the following distribution of channel types, shown in Table 159.

Table 159. Montgomery and Buffington (1997) channel types represented in reference and managed PACFISH-INFISH Biological Opinion monitoring sites*

Channel Type	Reference (number of sites)	Managed (number of sites)
Forced pool riffle	30	6
Plane bed	99	108
Pool riffle	108	166
Step pool	22	14
TOTAL	259	294

* Reference sites are located throughout national forests in the interior Columbia River basin and include 19 sites in the Blue Mountains. Managed sites displayed here are all in the Blue Mountains.

Forced pool riffle streams were only identified as streams with channel slope greater than 0.015 (1.5 percent) and with large wood frequency greater than the 75th percentile of all reference sites, or 1,000 pieces per mile. Thirty reference reaches, but only 6 managed sites, met this criteria. Because it was not possible to identify reaches in which the majority of pools were formed, or forced, by large wood, lower gradient streams (with gradients less than 1.5 percent) were classified as pool-riffle streams if they displayed evidence of lateral channel migration or point bar formation on satellite imagery, whether or not they met the large wood criteria.

Pool riffle streams were identified as meandering, or high sinuosity, low gradient streams, in unconfined valleys and consisting of clearly identifiable alternating sequences of pools and riffles.

Plane bed streams, based on Montgomery and Buffington (1997) are reaches in which the largest bed material is large relative to the mean channel depth. The high hydraulic roughness that results restricts bar development and pool formation. Plane bed streams commonly have average pool spacing greater than 9 channel widths between pools, compared to 4 to 6 channel widths between pools in pool riffle streams, and 1 to 4 channel widths per pool in step pool streams (Montgomery et al. 1995).

Step pool streams consist of sequences of vertical steps and plunge pools in which step height is typically determined by the largest bed particles (Grant et al. 1990). Pool spacing in step pool streams ranges from 1 to 4 channels widths based on data in Montgomery et al. (1999). Step pool streams were not initially included in the PACFISH-INFISH Biological Opinion monitoring network. None of the monitoring sites were classified as cascade channel types, but would have been excluded from analysis because there would have been too few reaches from which to identify a representative range of channel attributes.

Buffington and Montgomery (2013) report the middle 50 percent (between 25th and 75th percentiles) of values of different channel attributes as “characteristic” of the channel type. The middle 50 percent of values for PACFISH-INFISH Biological Opinion reference pool riffle, forced pool riffle, plane bed, and step pool streams is shown in Table 160.

Table 160. Range (25th to 75th percentiles) of attributes of Reference PIBO sites by channel type and for all sites

Attribute	Pool riffle	Forced pool riffle	Plane bed	Step pool	All Sites
Valley width/bankfull width	4 – 11	2.4 – 7.1	2.8 - 5.0	2.7 – 3.5	3.0 – 7.4
Channel slope (%)	0.5 – 1.4	1.7 - 2.3	1.6 - 2.7	3.0 - 4.4	1.0 – 2.4
Large wood frequency (pieces/mile)	280 - 1200	1200 - 1700	180 - 520	180 - 1020	257-1040
Large wood volume (m^3/km)	43 - 218	56 -142	23 - 150	34 - 185	41 - 215
Width/Depth (bankfull)	10.7 - 18.5	11.5 - 19.6	15.2 - 24.9	12.6 - 16.1	12.5 - 21
D50 (median bed sediment size in mm)	9 - 45	24 - 65	56 - 99	67 - 104	26 - 81
Percent fines less than 6 mm	10 - 35	8 - 26	3 -14	4 - 20	4.8 - 24
Percent undercut bank	34 - 55	26 - 52	18 - 36	20 - 45	24 - 51
Bank Angle (degrees)	104 - 127	90-115	107-127	96 - 122	92 - 119
Pool spacing (W/pool)*	2.6 - 4.2	2.1 - 3.0	3 - 8	3.2 - 4.9	2-8 – 5.5
Pools per mile	43 - 105	56 - 141	20 - 59	42 - 93	32 - 94

* Pool spacing measures the distance between pools in multiples of bankfull channel width. For example, in a stream with 100 pools per mile, pools are 52.8 feet apart. For a bankfull width of 20 feet, W/pool would be 2.6; for a bankfull width of 10 feet, W/pool would be 5.3. In PIBO reference sites, pool spacing in 92% of pool riffle is less than 6 channel widths per pool.

Table 159, Table 160, and Table 161 show that reference and managed sites contain different distributions of channel types and that channel properties vary between channel types. Pool spacing is smallest in pool riffle streams but also is small in streams in which large wood is abundant. Undercut banks are more prevalent in pool riffle and forced pool riffle streams than in plane bed streams. Reference and managed sites are composed of different distributions of channel types and channel sizes. Width/depth ratio and pool depth, among other attributes, vary by channel type, but also by channel size.

Montgomery et al. (1995) compared pool spacing to wood abundance in streams in western Washington and southeast Alaska. They found that pool spacing in plane bed streams increases rapidly when wood abundance is reduced, but that lower gradient streams still retain pool riffle morphology at low wood density (see Figure 28). Based on this relationship, Montgomery et al. suggested that plane bed streams should be rare in forested watersheds. However, about 40 percent of randomly selected PACFISH-INFISH Biological Opinion reference monitoring sites are plane bed streams and it appears that they are relatively common. Montgomery et al. (1995) suggested that the relationship could be used to identify reaches where the addition of large wood could contribute to increased pool frequency. In this analysis, it appears that loss of large wood, and subsequent channel degradation and pool loss is a common mechanism of channel alteration and represented by the conversion of pool-riffle streams to plane bed streams (Figure 29).

Table 161. Range (25th to 75th percentiles) of attributes of PACFISH-INFISH Biological Opinion managed monitoring sites by channel type and for all sites

Attribute	Pool riffle	Forced pool riffle	Plane bed	Step pool	All Sites
Valley width/channel width	5.6 - 14.8	4.2 – 6.3	3.3 – 7.5	2.7 - 4.9	4.2 – 11.2
Channel slope (%)	0.6 – 1.8	1.7 – 2.3	1.8 – 2.9	4.0 - 7.2	0.9 – 1.2
Large wood frequency (pieces per mile)	66 - 160	1140 - 1290	109 - 374	175 - 723	97 - 423
Large wood volume (m^3/km)	6.4 – 99.3	252 - 461	21 - 103	47 - 241	14 - 112
Width/Depth (bankfull)	9.0 – 18.4	10.6 – 22.7	14.1 – 22.8	10.1 - 17.4	10 - 20
D50 (median bed sediment size in mm)	8.0 – 37.8	3.5 – 27.0	4.2 – 12.9	24 - 62	12 - 61
Percent fines less than 6 mm	11 - 61	20 - 90	4 - 13	17.6 - 21.1	6 - 41
Percent undercut bank	17 - 37	31 - 41	9 - 27	20 - 25	12 - 33
Pool spacing (W/pool)	2.9 – 5.2	1.7 – 3.0	3.2 – 6.4	2.4 - 9.3	2.9 – 5.8
Pools per mile	66 - 160	81 - 189	38 - 118	63 -132	52 - 149

Reference reaches have higher instream wood frequency (758 pieces per mile vs. 327 pieces per mile) and volume (163.6 cubic meters per kilometer vs. vs. 88.5 cubic meters per kilometer) than managed reaches. However, PACFISH-INFISH Biological Opinion monitoring sites do not necessarily display the distribution of instream wood within channel networks completely, because steeper transport reaches are sampled at much lower intensity.

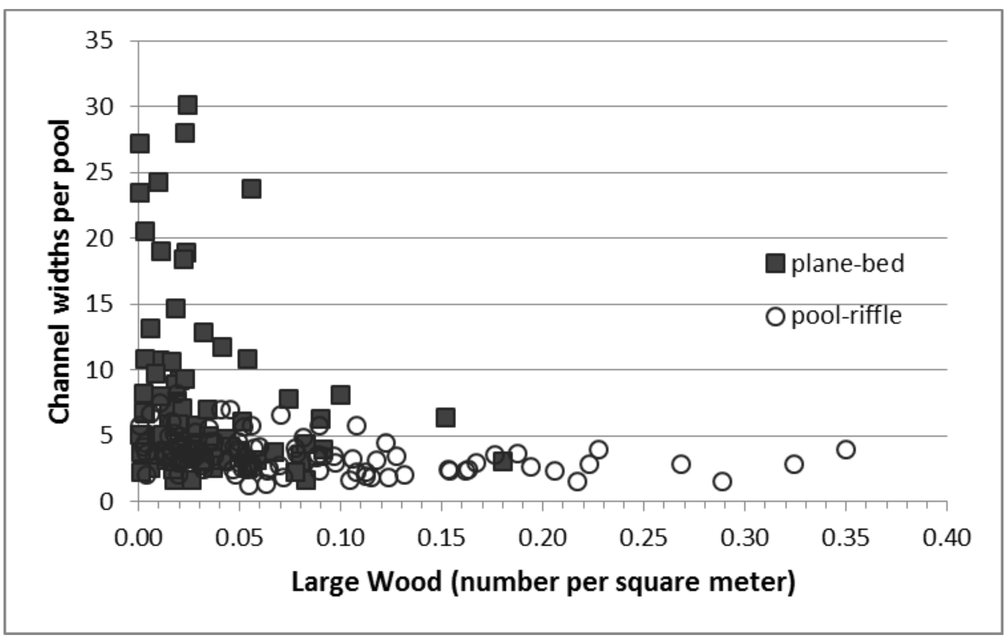

Figure 28. Wood abundance (density) versus pool spacing for reference plane bed (filled squares) and pool riffle (open circles) after Montgomery et al. (1995). Data from PACFISH-INFISH Biological Opinion monitoring reference sites. Pool spacing increases rapidly in plane bed streams when wood density decreases below about 0.10 pieces per square meter, but pool spacing remains low in pool riffle streams because lower gradient streams can retain their channel morphology when wood abundance is lower.

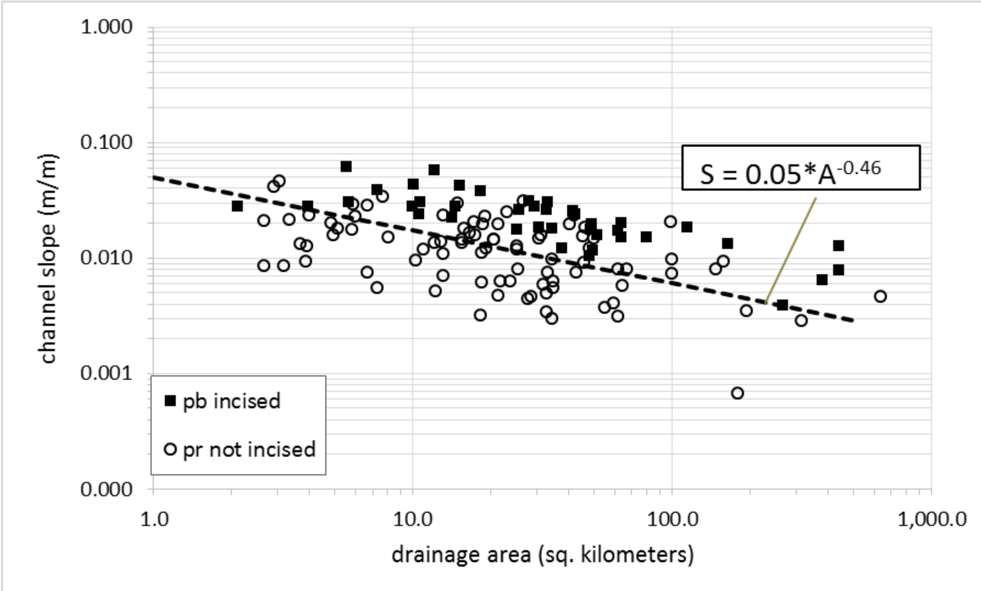

Figure 29. Drainage area vs. channel slope for plane bed (pb, filled squares) and pool riffle (pr, open circles). The dashed line separates un-incised and incised pool riffle streams. Plane bed streams (squares) in this plot are reaches in which channel type may have changed from pool riffle to plane bed, possibly by the removal or loss of large wood. Pool riffle streams (open circles) that plot above the line represent reaches that may be susceptible to the same change in channel type.

There are statistically significant differences in wood abundance between reference reaches in glaciated valleys and non-glaciated (fluvial sites in this analysis) valleys. Large wood frequency is nearly twice as high (1,045 pieces per mile) at reference sites in glacial valleys than in fluvial valleys (559 pieces per mile). At least some of the difference in wood volume is due to differences in vegetation type, as well as from differences in physiographic setting, including differences in elevation, precipitation, and valley type. The large difference in wood abundance between glacial and fluvial valleys suggests that large wood frequency values for reference sites in glacial valleys may not be achievable at managed sites in the Blue Mountains.

The difference in wood volume in reaches in glacial valleys (132 cubic meters per kilometer) and fluvial valleys (79 cubic meters per kilometer) is nearly as great as the difference between all reference sites and managed sites in the Blue Mountains. Some reasons for the higher wood abundance in streams of glacial valleys are that they occur at higher elevation, receive more precipitation, likely have different vegetation types, and experience longer periods between fires, all of which can contribute to large tree size. The mechanism of wood delivery appears to be more active in glaciated valleys where snow avalanches are common and can occur in most years. Due to differences in vegetation type, tree size, disturbance histories and valley type, the deficit of instream wood for stream in the Blue Mountains is estimated to be in the range of 170 to 460 million board feet, or 17,000 to 50,000 board feet per mile. Step-pool and cascade reaches account for only 22 of 259 (8%) reference reaches but wood abundance is similar to pool-riffle streams (51 sites in fluvial valleys, 57 sites in glacial valleys). Aquatic inventory data collected from streams in the Blue Mountains, consisting primarily of plane bed and step pool streams indicate that wood abundance may be 50 to 75 percent lower (average: 71 per mile) than is found in managed PACFISH-INFISH Biological Opinion monitoring sites (average 327 per mile), and 90 percent lower than the average of all reference sites (average 758 per mile), indicating that the wood deficit in local streams may be at the high end of the range stated above.

Twelve of 259 (5 percent) of reference streams are incised, meaning the channel bed has been lowered by erosion. In comparison, at least half of all managed sites are incised streams. In some reaches in the Blue Mountains, it is apparent that channel degradation is at least several decades old, and in some cases more than a century old. Murderers Creek, a tributary of the South Fork John Day River is an example where the stream has incised, then developed a new floodplain at an elevation 4-6 feet lower than the former valley floor. Trees growing within the new, inset floodplain are 70-80 years old, and indicate the minimum age of channel degradation and terrace formation.

The mechanisms of channel degradation in the Blue Mountains are not apparent in all cases, but include channelization, wood removal, splash damming, riparian degradation, constriction by roads, and historic livestock grazing, among others. Increased runoff from roads could lead to channel erosion due to higher peak flows that contribute to channel degradation.

The Grande Ronde River is cited as an example of land use effects, including timber harvest, extensive road construction, and livestock grazing, that have led to degraded channel conditions. The river was channelized in 1870 by construction of the State Ditch in the Grande Ronde Valley, which shortened the river by as much as 40 miles downstream of Island City (Hampton and Brown 1964). The difference in channel slope between the historic channel and the straightened channel was roughly 3 to 4 feet per mile and created the potential for channel degradation of up to 30 feet over the 8-mile length of the State ditch.

The construction of splash dams to facilitate log transport on the Grande Ronde river began by 1889 according to McIntosh et al. (1994) but log drives may have begun as early as 1876 (Farnell 1979). Splash dams were located at Perry, Dark Canyon, Limber Jim Creek, Meadow Creek, and at Vey Meadows in order to transport logs by river to the mill at Perry. The dam at Perry was built to store up to 7 million board feet of logs and ponded water for two miles upstream. Logs were harvested and stored in winter, then released through splash dams in spring. Splash damming typically involved removing instream wood or other obstructions that would prevent log transport. Splash dammed reaches often are scoured to bedrock by the repeated release of high flows and force of the logs being transported (Sedell et al. 1991). It is possible that the Grande Ronde remained stable while the splash dams were in place, at least at Perry. Of the 10 largest known floods on the Grande Ronde River at La Grande, 3 occurred during the time splash dams were in place: in 1904, 1910, and 1912, two occurred immediately after the dams were removed in 1919 (1921, 1929) and another large flood occurred in 1932. The flood of 1910 was second in sediment transport capacity only to the flood of record in January 1965. Removal of the dams in in 1919, followed by floods in 1921 and 1922 likely allowed channel erosion to proceed upstream. A preliminary estimate of amount of sediment eroded from the channel and flood plain of the Grande Ronde River and comparison to an estimate of sediment transport capacity suggests that multiple floods over a time period of 100 years or more are required for the river to have eroded to its present state.

At present, the Grande Ronde River is lower than the valley floor in the Grande Ronde Valley by 12 to 18 feet over the length of the State Ditch. Channel incision is 8 to 12 feet between Perry and Hilgard and it is possible that the depth to bedrock in this reach limited the depth of channel erosion. The Grande Ronde River is incised for a length of over 40 miles to upstream of Vey Meadows where channel erosion of 2 to 4 feet has occurred. Downstream of the State Ditch, base level of the river is controlled by the canyon between Imbler and Elgin and little erosion has occurred. Upstream, base level is controlled by the depth to bedrock in the canyon between Perry and Hilgard. Upstream of Hilgard, the river was isolated from its floodplain by the construction

of railroad lines along the upper Grande Ronde and tributaries. It is probable that construction of the State ditch, followed by splash dams and log drives induced channel erosion by the time the dam at Perry was removed. Removal of the dam changed the base level of the river. As the riverbed eroded upstream, tributary streams would have eroded to the new base level by eroding downward and channel erosion would have been further enhanced by the removal of instream wood that would have occurred prior to use of the river for log drives. Once isolated from its floodplain the river would have widened and deepened to accommodate flood flows and is likely larger in cross-sectional area than before channel incision occurred (Leopold, Wolman and Miller 1964). The eroded channel lacks pools, as documented by McIntosh et al. (1994), has higher sediment transport capacity than sediment supply, and is wide and shallow (high width/depth ratio), especially at low flow. Most of the channel bed is composed of coarse material that is movable only at very high flow. Abundant coarse bed material and the shallow depth to bedrock make it likely that the Grande Ronde River lacks the ability to form pools over much of its length.

Montgomery et al. (1995) illustrated a relationship between wood abundance and pool spacing (Figure 29) and Buffington et al. (2002) related pool formation to flow obstructions, including large wood and noted that larger pools are associated with larger obstructions, and particularly obstructions formed by large wood. Large wood in streams creates hydraulic roughness that reduces flow velocities and allows gravel retention in the channel. In some streams, the presence of large wood is responsible for forced pool riffle morphology (Montgomery and Buffington 1997), or formation and retention of spawning gravel in otherwise bedrock streams (Lamberti et al. 1991, Massong and Montgomery 2000). Figure 28 illustrates the case where a decrease in wood abundance results in results in conversion of pool riffle streams to plane bed streams.

20th Century Climate and Projected Climate Change

The Blue Mountains are span roughly 230 miles from north to south and 170 miles from east to west. The northern Blue Mountains border the Columbia Basin and the southern Blue Mountains border the northern Great Basin. The climate is predominantly continental with cool to cold winters and hot, dry summers (Ferguson 1999). A maritime influence affects the northern Blue Mountains due to the gap in the Cascades at the Columbia Gorge that allows moist air eastward during Pacific Frontal storms. Marine air that enters the Columbia Basin via the Columbia River Gorge is largely blocked by the Blue Mountains from entering the Great Basin. The varied topography within the Blue Mountains and large aerial extent result in differing interactions of arctic, maritime, and continental air masses that affect the distribution of temperatures and whether precipitation falls as rain or snow within the Blue Mountains.

During the 20th century average temperatures in the Pacific Northwest increased by 1.4 degrees Fahrenheit with about half of the warming since 1970 (Mote 2003) and annual precipitation increased about 14 percent. In Oregon Climate Zone 8, which encompasses the Blue Mountains, average temperature increased nearly 1.6 degrees Fahrenheit in the 20th Century (Figure T) but there was little or no trend in precipitation. The average temperature during the 20th century was 43.4 degrees Fahrenheit, but the average for the period 1970-1999 was 43.9 degrees Fahrenheit, indicating that the rate of warming increased after 1970.

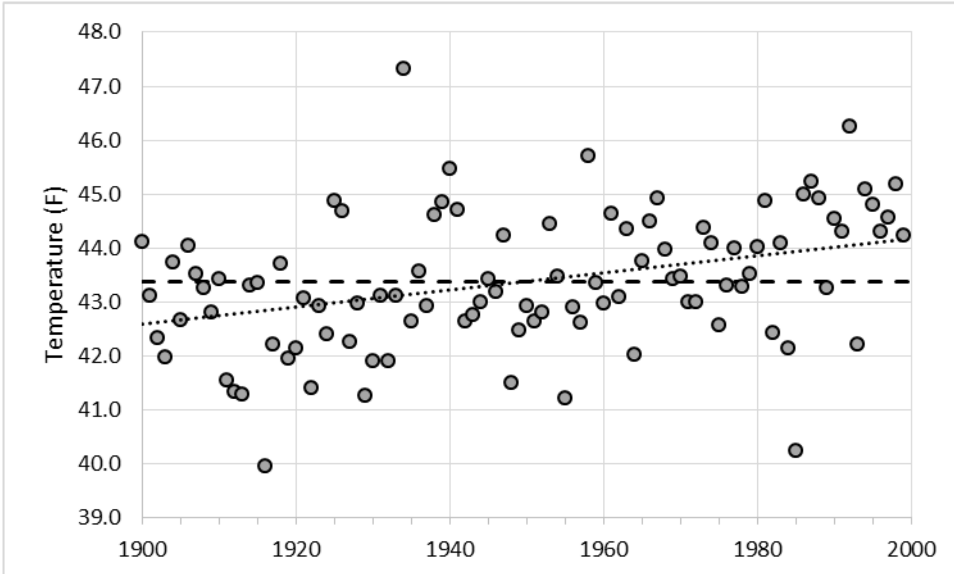

Figure 30. Annual average temperature for Oregon Climate Zone 8 (1900-1999). Dashed line is the 20th Century average (43.4 degrees Fahrenheit); dotted line is the trend in temperature over the 20th Century

Increased temperatures expected in the 21st century are substantially greater than the warming observed in the 20th century. In the Pacific Northwest and in the Blue Mountains, temperature is projected to continue to increase by 2.0 degrees Fahrenheit to 8.5 degrees Fahrenheit (1.1 degrees Celsius to 4.7 degrees Celsius) by 2041-2070 compared to the period 1970-1999 (Mote et al. 2013, Clifton et al 2017). However, in a more recent analysis, Dalton et al. (2017) project temperatures in Oregon to increase by 3-7 degrees Fahrenheit by the 2050s and 5-11 degrees Fahrenheit by the 2080s, with the lower range only possible if greenhouse gas emissions are significantly reduced. In Oregon Climate Zone 8, the 2000-2016 average temperature of 44.9 degrees Fahrenheit is higher than the 20th century average of 43.4 degrees Fahrenheit by 1.5 degrees Fahrenheit, and higher than the 1970-1999 average of 43.9 degrees Fahrenheit by 1.0 degrees Fahrenheit, demonstrating that temperatures in the area continue to warm.

Warmer winter temperatures are linked to declines in winter snow pack (Mote 2003, McCabe and Wolock 2009, Kapnick and Hall 2011); warmer spring temperatures are linked to earlier snowmelt (Cayan et al. 2001, Stewart et al. 2005) and streamflow timing (Barnett et al. 2005, Cayan et al 2001, Stewart et al. 2005). Warmer temperatures lead to increases in the amount of precipitation falling as rain versus snow (Knowles et al 2006), and lower summer flows (Luce and Holden 2009).

Warmer spring temperatures in the western U.S. have contributed to earlier runoff timing (Hamlet et al. 2005). Warmer spring temperatures, especially in March and April appear to be contributing to earlier streamflow in the Blue Mountains. At the 16 gage sites in the Blue Mountains with the longest periods of record, all 16 sites have higher runoff in March (average 40 percent increase) and February (average 8 percent) for the period 1980-2009 compared to 1941-1970, and 14 of 16 sites have lower June streamflow (average -8 percent; see Figure 31 and Figure 32). Together, these changes indicate a shift towards earlier runoff that is consistent with the expected effects of climate change.

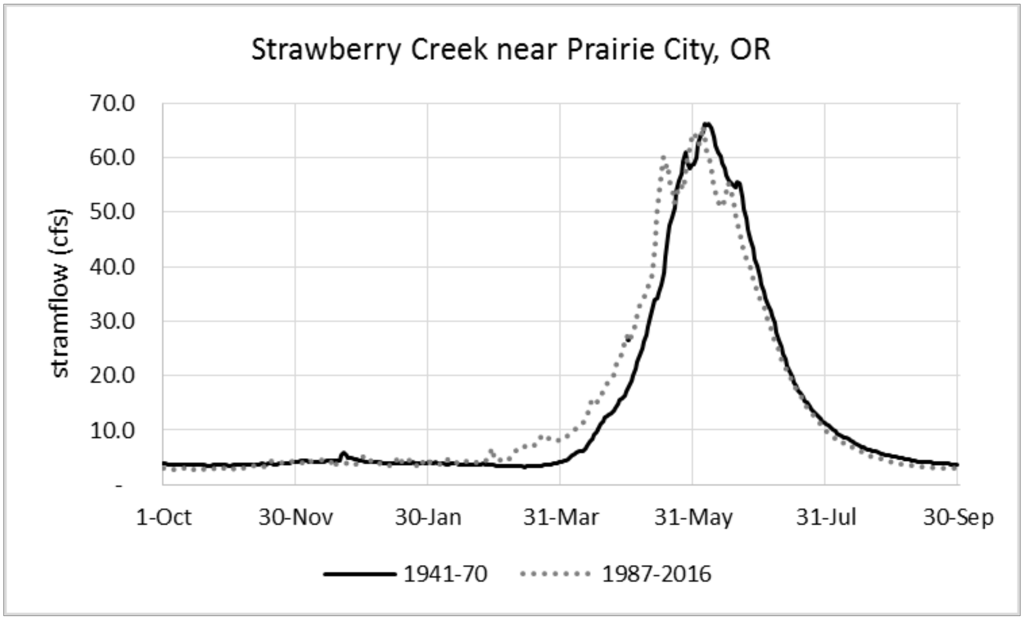

Figure 31. Average mean daily flow for water years 1941-1970 (solid line) and 1987-2016 (dashed line). March streamflow is 94% higher and April streamflow 52% higher during 1987-2016.

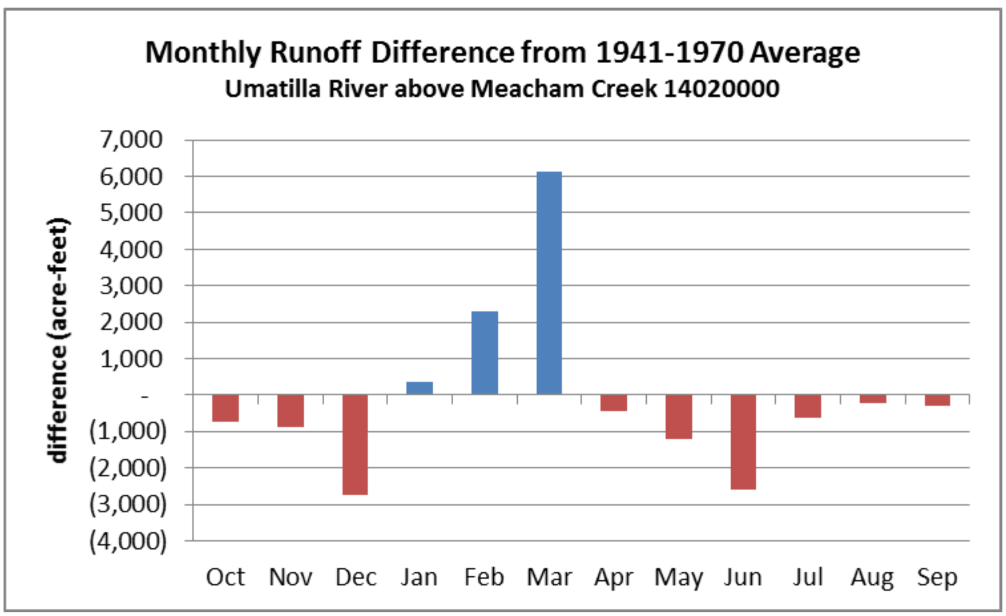

Figure 32. Monthly streamflow difference (acre-feet) by month, 1980-2009 average relative to 1941-1970, Umatilla River above Meacham Creek, near Gibbon, Oregon

The amount of precipitation falling as rain versus snow is a function of temperature, but also affected by the trajectory, or storm track of approaching Pacific storms. Storms approaching the West Coast from the southwest are more likely to entrain warmer tropical air and often bring heavy rain (Weaver 1962), while the circulation around low-pressure systems approaching from the northwest is more likely to draw cold air from the interior of Canada and bring snow to eastern Oregon and Washington. Some storms that draw tropical air towards the U.S. West Coast are known as atmospheric rivers (Zhu and Newell 1994) and the strongest of these storms appear

to be responsible for every winter flood peak on the Grande Ronde River, and the majority of winter peaks on all other rivers in the Blue Mountains. To date, only a few high elevation streams in the Blue Mountains have never recorded a winter flood peak, but there appears to have been increase in atmospheric river type storms in northeast Oregon since about 1950. Expected warming during the 21st century makes it likely that atmospheric river storms will bring rain to successively higher elevations of the Blue Mountains in the future.

Current climate projections are that snow accumulation will decline, snow-dominant watersheds will become mixed rain and snow basins, and mixed rain and snow basins will become rain dominated by the 2040s. Large areas of the Blue Mountains are expected to be snow free by the 2080s (Luce et al. 2014) with snow persisting only in high elevation areas, such as the Wallowa, Elkhorn, and Strawberry mountains.

Precipitation and streamflow extremes are likely to increase, with higher peak flows (Hamlet et al. 2013) as well as lower low flows (Luce et al. 2009, Tohver et al. 2014). Low elevation areas within and surrounding the Blue Mountains may see less decline in low flows because they are already dry and have less soil moisture to lose (Tohver et al. 2014). Wenger et al. (2010) predicted less than a 10 percent decline in low summer flow for 47 percent of perennial streams by the 2080s.

Lower summer flows will likely lead to warmer stream temperatures (Isaak et al. 2010, Isaak et al. 2017). The areas with warm summer stream temperatures are expected to expand and the areas with cooler stream temperatures to contract. August stream temperatures could increase by 1.8 degrees Fahrenheit by the 2040s and 3.6 degrees Fahrenheit by the 2080s (Isaak et al. 2015).

Projected air temperature changes will gradually result in rainfall at successively higher elevations. In most mid- and low-elevation gage sites in the Blue Mountains, winter rain events are relatively common but a few high elevation watersheds appear never to have had winter flood peaks. These watersheds are generally located at the highest elevations in the Blue Mountains, have average elevations near 6,000 feet, are predominantly north-facing, and located mainly in the Wallowa, Elkhorn, and Strawberry Mountains.

Higher temperatures, reduced snowfall, and earlier snowmelt will extend the summer dry season. Water demand by forest vegetation will increase, and forests will be subject to increased drought stress because soils will dry earlier in the summer and the dry period will extend to later in the year. This is likely to lead to increased forest mortality (Adams et al. 2009, van Mantgem et al. 2009) and increased extent and severity of wildfires (Westerling et al. 2006, Littell et al. 2010).

Several basins in the Blue Mountains in which irrigation water use is already high are more likely to be subject to water shortages in the near future. Increased temperatures make extended, multi-year droughts more likely. The Third Oregon Climate Assessment (Dalton et al. 2017) suggests that 2015, the warmest and one of the driest years on record, may represent “normal” conditions by mid-century in the Pacific Northwest.

Some suggested adaption measures to the effects of expected changes in temperature and precipitation include: increasing the capacity of floodplains and riparian areas to retain water, flood proofing vulnerable roads, increasing the extent of beaver created wetlands, improving road drainage, and implementing measures to reduce road surface erosion (Luce 2018). All of these measures are stated objectives of the revised forest plans.

Land Uses Affecting Watershed Function

Major land uses influencing watershed functions in forested watersheds include roads, timber harvest, wildland fire, and livestock grazing. Each of these land uses, their potential influence on watershed conditions, and their rationale for use in this analysis are described in the following sections.

Roads

The hydrological effects of National Forest System roads include alteration of the rates of surface runoff and increased rates of erosion and sediment delivery to streams and result in degraded water quality and aquatic habitat (Furniss 1991). Roads are the leading source of sediment delivery to streams in forested watersheds (Sugden and Woods 2007, MacDonald and Coe 2008). Roads affect the rates of watershed runoff by intercepting subsurface runoff and rerouting it directly to streams, resulting in higher peak flows. Roads constructed next to stream channels restrict lateral migration of the channel and may confine high flows, contributing to channel degradation. Roads located next to streams also replace riparian vegetation, reduce stream shade, and otherwise eliminate the benefits to streams that riparian zones would otherwise have. Streams have often been straightened or constricted during road construction, which contributes to channel and bank erosion.

Many valley-bottom roads in the Blue Mountains were originally railroad grades with elevated beds. Some of these roads contributed to isolation of rivers from floodplains, and others served to isolate tributary streams from main-stem rivers, by disrupting both stream flow and sediment transport. Mid-slope roads can disrupt the flow of water as well as the transport sediment and wood during high flow events.

In the Blue Mountains, 24 percent of stream miles on the Malheur National Forest, 5 percent of stream miles on the Umatilla National Forest and 11 percent of stream miles on the Wallowa-Whitman National Forest have roads within 100 feet of the channel. In addition, timber harvest has occurred in 24 percent of the area within 100 feet of streams on the Malheur, 29 percent on the Umatilla, and 14 percent on the Wallowa-Whitman. In forested watersheds, road density has been used as a measure of land use intensity (Lee et al. 1997) and is related to a variety of human uses, including logging, livestock grazing, and motorized recreation. In addition, Lee et al. (1997) showed a negative relationship between road density and the population strength of four resident fish species in subwatersheds in the Interior Columbia River Basin in which no strong populations of any of the four species was present when road density exceeded 1 mile per square mile.

Roads increase the rate of watershed runoff and contribute to reduced low flows, increased peak flows, or both, but these effects are primarily documented in controlled studies of small watersheds and are more difficult to detect in larger watersheds in which runoff processes are more complex (Grant et al. 2008). However, it is likely that roads affect all surface runoff events and are a persistent effect on the magnitude of all peak flows (Grant et al. 2008). The effects of roads increase with increases in the hydrologic connection of roads to the stream channel network (Jones and Grant 1996, Wemple et al. 1996). Roads that are closer to stream channels have a greater potential for sediment delivery to streams (Haupt and Kidd 1965, Wemple et al. 1996), but Montgomery (1994) suggests that ridgetop roads can also contribute to increased runoff. Croke et al. (2005) found that the greatest contribution to runoff occurred at stream crossings where road runoff discharges directly into streams. McIntosh et al. (1995) observed that nearly 90 percent of

streams in managed watersheds in the Columbia Basin had roads either along the channel or within the floodplain for at least part of their length.

Effects of roads on watershed function vary greatly due to the influence of such factors as topography, geology, slope stability, road design, and the amount of traffic on a particular road (Bilby et al. 1989, Duncan and Ward 1985, Luce et al. 2001, Wemple et al. 2001, Swanson and Dyrness 1975, Sugden and Woods 2007). Rates of road surface erosion and sediment delivery to streams vary with disturbances (floods and fire), and range from episodic pulses to chronic contributions of sediment (Switalski et al. 2004). Unsurfaced roads generally have higher erosion rates than gravel or paved roads (Reid and Dunne 1984, MacDonald and Coe 2008) and highest erosion rates occur on steeper roads and unsurfaced roads with the most vehicle traffic (Reid and Dunne 1984, Welsh 2008, Sosá-Perez and MacDonald 2017).

Roads on National Forest System lands may intercept subsurface runoff from hillslopes and route it through the road drainage system into the channel network (Megahan 1972, Megahan and Clayton 1983). Wemple et al. (1996) cited two hydrologic flow paths that resulted in the integration of road systems and channel networks: roadside ditches that drain to streams and roadside ditches that drain to culverts with gullies below their outlets. These roads are "hydrologically connected" to the channel.[25]

The production of road-related sediment varies with geology (Duncan and Ward 1985, Sugden and Woods 2007). In steep terrain, roads increase the rates of hill slope failures and soil mass wasting (Swanston and Swanson 1976, Swanston 1991). McCashion and Rice (1983) noted that 51 percent of observed erosion in a northern California watershed occurred on roads constructed on slopes steeper than 60 percent. Fine sediments can be delivered to natural streams by erosion of road surfaces and from unvegetated road cut and fill surfaces (Reid and Dunne 1984). The amount of road surface erosion increases with the amount of road traffic (Reid and Dunne 1984, Bilby et al. 1989) and varies with topography, sensitivity to land sliding and mass wasting (Furniss et al. 1991). Road-stream crossings are common sources of sediment, for example, when culverts are blocked by debris, when runoff is routed along the road surface (Furniss et al. 1998), or when road drainage ditches extend to the channel crossing.

Road density has been used as a measure of past land use intensity, particularly in areas of active timber harvest (Lee et al. 1997, Sharma and Hilborn 2001). However, Lee et al. (1997) acknowledged the difficulty in discriminating the varying effects of roads over large landscapes and suggested that local conditions can have a large influence on runoff and sediment delivery from a given road segment. McCaffery et al. (2007) found significant relationships between fine sediment in streams and road density, open road density, and number of stream crossings. Jorgensen et al. (2009) used road density as one of several factors to predict stream temperatures and substrate characteristics in the evaluation of habitat quality for Chinook salmon in the Wenatchee River, Washington. Cederholm et al. (1981) noted an association of fine sediment accumulation in headwaters streams in heavily roaded areas of the Clearwater River basin in Washington and noted an increase in sediment production by 2.6 to 4.3 times when road density exceeded 2.5 kilometers per square kilometer (4 miles per square mile). An analysis of National Forest System roads within the Umatilla National Forest in the Wall Creek watershed indicates that 90 percent of road-related sediment is produced by 12 percent of the road network. This

[25] Hydrologically connected roads are defined as roads or portions of roads that route water and/or sediment directly to stream channels.

information is now used to prioritize erosion reduction treatments at the most critical sites (Nelson et al. 2010).

Effects of roads to watershed function may be reduced by considering location, design, and management to disperse road runoff (Furniss et al. 1991). Examples include road surfacing (Burroughs and King 1989, Bilby et al. 1989), seasonal road closures to protect both unsurfaced and surfaced (crushed aggregate or gravel) roads from use during adverse weather, and designating undisturbed riparian zones along streams to allow filtering of fine sediments (Newbold et al. 1980). Madej (2001) found that road decommissioning greatly reduced, but did not eliminate road-related sediment delivery to streams. Haupt and Kidd (1965) suggested that 30-foot wide riparian buffers were sufficient to prevent road-related sediment delivery to streams. In contrast, Ketcheson and Megahan (1996) suggested that 100-meter (330 feet) buffers may be insufficient to prevent sediment delivery to streams, depending on geology and the steepness of adjacent slopes.

Lastly, not all effects of roads are preventable. McCashion and Rice (1983), in a study of forest road effects in northern California, concluded that as little as 24 percent of road-related erosion was avoidable. In contrast, Megahan et al. (1992) concluded that, while some increases in sedimentation due to forest roads are unavoidable, road-related sediment delivery to streams in the Salmon River basin of Idaho could have been reduced by 45 percent to 95 percent using available management practices. The management practices considered included improved road design (45 percent reduction), maximizing erosion control (73 percent reduction), and helicopter logging, thus reducing the required road network by more than 90 percent (95 percent reduction). Management practices that avoided or minimized road construction were the most effective at preventing road-related erosion.

Miles of existing roads, open roads, and riparian roads on each national forest are displayed in Table 162. Riparian roads, as used in this analysis, are approximated by the miles of roads within 300 feet of any stream channel. This is intended as an approximation of the total miles of "hydrologically connected" roads, but not necessarily specific roads. Actual road connectivity depends not just on proximity to streams, but in the type and location of road drainage and the location of drainage features relative to the channel network, the layout and design of the road network, road density, channel network density, and local climate, geology, and topography. Some studies have shown that road-stream connectivity depends on storm magnitude, meaning that road-stream connectivity is likely highest during the strongest storms.

Table 162. Miles of existing roads and open roads for each national forest (2015 data)

Road Type	Malheur	Umatilla	Wallowa-Whitman	Totals
Existing roads	9,423	4,512	8,283	22,218
Open roads	5,713 (61%)	2,366 (52%)	4,193 (51%)	12,273 (55%)
Riparian roads	3,300 (35%)	1,510 (33%)	3,332 (40%)	9,035 (37%)

Existing and open road densities are displayed in Table 163. Open road densities range from 1.1 to 2.1 miles per square mile and average 1.6 miles per square mile across all three forests. Existing roads in Table 163 are the sum of open and closed system roads. Not including wilderness and inventoried roadless areas, open road density averages 2.45 miles per square mile and existing road density averages 4.4 miles per square mile across all three forests. This difference effectively separates "roaded" and "unroaded" areas of each national forest.

Table 163. Road density (miles) for each national forest

Road density, including wilderness areas and existing roadless areas	Malheur	Umatilla	Wallowa-Whitman	Totals
Existing road density (all NFS lands)	3.53	2.06	2.98	2.91
Open road density (all NFS lands)	2.14	1.08	1.51	1.61
Road density, excluding wilderness areas and existing roadless areas	**Malheur**	**Umatilla**	**Wallowa-Whitman**	**Totals**
Existing road density	4.19	4.63	4.62	4.43
Open road density	2.54	2.43	2.34	2.45

Malheur National Forest – There are 177 subwatersheds within or partially within the Malheur National Forest, of which 143 have more than about 500 acres of National Forest System lands. Average density of existing roads is 3.9 miles per square mile. Average road density in key and priority watersheds is 3.9 miles per square mile, and average road density is 4.6 miles per square mile in watersheds named as priorities for restoration. Since 1990, 3,709 miles of roads have been closed and 875 miles of roads decommissioned within the Malheur National Forest.

Umatilla National Forest – There are 162 subwatersheds within or partially within the Umatilla National Forest, of which 129 contain more than about 500 acres of National Forest System lands. Average road density in these watersheds is 2.2 miles per square mile. Road density in key and priority watersheds is 1.5 miles per square mile, and 2.0 miles per square mile in priority watershed only. Since 1990, 2,145 miles of roads have been closed and 370 miles of roads decommissioned within the Umatilla National Forest.

Wallowa-Whitman National Forest – There are 184 subwatersheds within or partially within the Wallowa-Whitman National Forest containing more than about 500 acres of National Forest System lands, not including the Hells Canyon National Recreation Area. Average existing road density is 2.98 miles per square mile. Average open road density is 1.5 miles per square mile. Existing road density in key and priority watersheds is 2.9 miles per square mile and is 3.9 in priority watersheds alone. Since 1990, 976 road miles were decommissioned and 4,090 miles of roads have been closed.

Forested Vegetation and Timber Harvest

Forested watersheds in the western United States are generally areas of higher elevation and consequently have more precipitation and greater streamflow than surrounding areas. The effects of timber harvest on forested watersheds has been described in terms of evapotranspiration and site water balance, snow accumulation and melt rates, and influences on soil structure, infiltration, and water transmission rates (Chamberlin et al. 1991).

Stand density and leaf area index are both related to site water balance (Grier and Running 1977). Forested vegetation intercepts a percentage of precipitation that is evaporated back to the atmosphere (Patric 1966, Stewart 1977), and much of the water that infiltrates forest soils is transpired through vegetation at least until water infiltrates past the rooting depth of vegetation (Ziemer 1979). The combined effect of evaporation and transpiration (evapotranspiration) may comprise 20 to 80 percent of precipitation in western U.S. watersheds and appears to be regulated by the difference between precipitation and potential evapotranspiration (Riggs and Wolman 1990).

Removal of forested vegetation by timber harvest (Goodell 1967, Bosch and Hewlett 1982, Jones 2000, Lewis 2001) and high-severity fires (Helvey 1980, Megahan 1983) has been shown to increase watershed runoff, at least temporarily, until forest cover is restored (Farley et al. 2005). Removal of vegetation in forested watersheds alters the watershed response to precipitation by reducing interception, evaporation, and transpiration and increasing soil water storage and runoff (Lewis et al. 2001, MacDonald and Stednick 2003). Water yield increases of 40 millimeters (1.6 inches) for each 10 percent change in forested cover have been documented in coniferous forests in the U.S. and elsewhere (Hibbert 1967, Bosch and Hewlett 1982), but this effect can be highly variable and may be decreased where young, fast-growing vegetation establishes quickly after logging (Hibbert 1967). Keppeler and Ziemer (1990) reported statistically significant increases in low flows and annual runoff following selective harvest in northern California but also reported that low flow increases diminished within five years. Ziemer (1964) reported that water savings from reduced evapotranspiration following clear-cutting diminished to zero after 16 years. Studies of the effects of timber harvest have predominantly been on small watersheds (Ziemer 1987) because runoff processes are simpler and making it easier to compare control and impact watersheds. Runoff processes are more complex in larger watersheds making the effects of timber harvest and roads more difficult to detect. Grant et al. (2008) suggest that the effects seen in small watersheds are likely the maximum and that harvest effects diminish as watershed size increases.

The effect of forest management on watershed runoff in rain and snow-dominated watersheds has been an active area of research for decades (Troendle 1983, Slaughter et al. 2001). Snow accumulation is strongly associated with both meteorological variables and forest characteristics (Anderson 1967). At higher elevations, creation of canopy openings by timber harvest may result in changes in the water content in winter snowpack and in the timing of snowmelt (Troendle and King 1985). Timber harvest has been observed to increase snow accumulation in forest openings and to result in earlier snowmelt timing (Moore and Wondzell 2005), and there is some evidence to suggest that forest management may increase the volume of snowmelt runoff (Pike and Sherer 2003). Kattleman et al. (1983) suggested that limited potential existed to modify water yields in Sierra Nevada watersheds through forest management because of the rate of harvest required to increase water yield and the recovery time of vegetation between harvests would make it difficult to sustain any flow increase (see also Ziemer 1964). A 30-year-long study of watershed response to timber harvest in the northern Blue Mountains, at the High Ridge evaluation area within the Umatilla National Forest, showed water yield increases were small, lasting only a few years even with clearcutting. As the study progressed in the 1980s, harvest effects to water quality from increased erosion and shade loss became more of a concern than the potential for increasing water yield. Practices used in the study, including clear-cutting and skidding across streams, were later restricted or prohibited (Helvey et al. 1995).

Processes that contribute to streamflow from adjacent hillslopes include overland flow, subsurface storm flow, and groundwater flow (Freeze 1974). In forested watersheds, the litter layer provides ground cover that contributes to high soil infiltration rates (Arend 1942) and low surface erosion (Plamandon et al. 1972). High infiltration rates in forested watersheds tend to limit the occurrence of overland flow (Harr 1977), except in cases where precipitation intensity exceeds infiltration capacity (Montgomery and Dietrich 1995), soils become saturated (Betson 1964, Dunne and Black 1970), or disturbance results in the loss of ground cover (Brandt 1987) or compaction of forest soils (Hills 1971).

The percent composition of the three dominant upland forest potential vegetation groups for each national forest, the average departure from the historical range of variability as described in the forested vegetation section of this document, and the acres of the different potential vegetation

groups are displayed in Table 164. The departure is expressed as the percentage difference between existing stand density, structure, and species composition compared to reference conditions (NIFTT 2010), which in this analysis is the historical range of variability. The methods used in the departure analysis are described in the Forest Vegetation section of this document. Dry upland forests have been the focus of timber harvest within the Blue Mountains national forests and are typically the most departed from historic conditions. The predominant direction of departure is towards dense stands of younger-aged trees and a decline in the number and distribution of older trees.

Table 164. Upland forest potential vegetation groups percent of total acres and percent departure from historical range of variability, and approximate acres for each national forest

Potential Vegetation Group	Percent Departure and Acres	Malheur	Umatilla	Wallowa-Whitman
Dry Forest	Percent of national forest [percent departure]	72% [66%]	42% [64%]	36% [63%]
Dry Forest	Approximate acres	1,231,000	595,000	640,000
Moist Forest	Percent of national forest [percent departure]	6% [53]%	31% [39%]	21% [30%]
Moist Forest	Approximate acres of national forest	95,000	431,000	372,500
Cold Forest	Percent of national forest [percent departure]	9% [61%]	8% [31%]	21% [39%]
Cold Forest	Approximate acres of national forest	160,000	113,000	368,000

Vegetation departure is used in this analysis as a measure of overall stand condition for both upland and riparian vegetation. Because water use by vegetation is the largest component of the water balance of forested watersheds after precipitation, it follows that changes in vegetation conditions result in variations in water use by vegetation that ultimately affect stream flow. Stand density may be limited by water availability (Littell et al. 2010), as well as by competition for space and light, making it likely that water use by vegetation is highest when stand density is highest, and vice versa. This analysis makes the simplifying assumption that desired vegetation conditions, are a reasonable approximation of desired hydrologic conditions as influenced by forest vegetation.

In the 1990 forest plans, 780,000 acres of the Malheur National Forest, 380,000 acres of the Umatilla National Forest, and 590,000 acres of the Wallowa-Whitman National Forest are considered suitable for timber production. The 1990 forest plans originally projected a combined annual timber harvest of 450 million board feet, but actual harvest levels declined sharply to an average of less than 100 million board feet per year by 2004. An average of 260,000 acres per year were expected to be harvested within all three National Forests in 1990, compared to the actual average harvest of 76,000 acres from 1998 to 2002. Additional information on the changes in harvest levels is described in the Forest Vegetation section of this document. A contributing factor in the decline of timber harvest volume and acres harvested has been the limitations placed on timber harvest within riparian habitat conservation areas following the implementation of PACFISH and INFISH in 1995. Within streamside zones, the departure of dry upland forests from the historical range of variability remains highly departed due to the combined effects of historic through recent timber harvest, fire exclusion, road construction, and other factors.

Beginning in 1995, management actions within riparian habitat conservation areas were intended to be limited to those that specifically benefitted aquatic and riparian-dependent habitats and the

species that occupy them. In the revised forest plans, the management intent remains that management actions within Riparian Management Areas will be designed to protect, maintain, or enhance water quality and the ecological health of aquatic and riparian-dependent habitats.

Riparian habitat conservation areas currently encompass an estimated 168,550 acres of the Malheur National Forest, 237,500 acres of the Umatilla National Forest, and 360,100 acres of the Wallowa-Whitman National Forest.

Wildland Fire

Wildland fire includes planned and unplanned ignitions. Unplanned ignitions may be either human caused or of natural origin. Planned ignitions (prescribed fires) are fires ignited by management and used under an existing management plan to achieve resource management objectives, including reducing the risk of high severity fire effects. Unplanned ignitions of natural origin may also be managed for resource objectives under various strategies based on values at risk and resource management objectives. Wildland fire activities and the associated effects on forested vegetation are described in greater detail in the “Forested Vegetation,” “Timber Resources,” and “Wildland Fire” sections. This section addresses the effects of wildland fire activities on watershed function, water quality, and water uses.

The forests in the Blue Mountains have historically developed under the influence of a variety of disturbances, including wildland fire, that have shaped species composition and stand structure (Johnson 1994, Agee 1998). The combined effects of forest management and fire exclusion since the early 1900s contributed to changes in forest structure and species composition, and the altered fire frequency and severity contributed to changes in forest patch size (Hessburg et al. 2005, Johnson 1994). Fire partially or completely consumes vegetation, partially or completely removes ground cover, and may form water repellant (hydrophobic) soil layers depending on soil temperatures during the burn and the characteristics of the local vegetation and soils (De Bano and Krammes 1966). Fire effects on watershed function depend on physical and biologic attributes of individual watersheds, on the severity of the fire, and on weather conditions following the fire. Low severity fires, by definition, consume little of the organic material that covers and protects the soil from surface erosion. High severity fires consume much of the above ground vegetation, soil organic material, and litter. Loss of ground cover can greatly increase the erosion risk of forest soils following a fire (Certini 2005, Miller et al. 2011), although actual erosion also depends on availability of sediment as well as soil erodibility (Moody and Martin 2009).

Increases in post-fire erosion in mountainous areas of the western U.S. highlight the impacts of wildland fire on watershed function (Roering and Gerber 2005). Erosion rates after large or high severity wildland fires may be elevated by more than a factor of 200 immediately after the fire (Morris and Moses 1987) but can decline to background levels in as little as three years (Moody and Martin 2001). Debris flows and shallow landslides often occur following fires (Wondzell and King 2003) or following any other mechanism that removes surface vegetation or affects root strength on susceptible sites (Reneau and Dietrich 1987). The occurrence of debris flows is governed by the magnitude of post-fire weather events, in combination with local geology and topography (DeGraff 1994, Shakesby and Doerr 2006, Coe et al. 2014, Cannon et al. 2010).

Historically, fire intensity was generally lower in riparian areas due to increased water availability and higher fuel and soil moisture, but accumulations of fuels in riparian zones and the potential for increased fire severity in riparian areas in recent years has elevated concerns about riparian area fuels management (Dwire and Kauffman 2003, Halofsky and Hibbs 2008, Dwire et al.

2010). Additionally, increased conifer crown density and ladder fuels have resulted in increased fire severity in some riparian areas, in comparison to historic conditions.

Prescribed fires used to reduce forest fuels typically create low severity burn conditions, but concentrations of fuels may burn at higher severities and develop areas of hydrophobic soil (Robichaud 2000). In a recent Blue Mountains study of prescribed fire effects on erosion and sediment delivery to riparian areas, treatments were found to have low on-site erosion and no sediment delivery to prescribed riparian protection zones (Harris et al. 2005).

High-severity fire may result in increased streamflow due to loss of vegetation and decreases in evapotranspiration (Helvey 1980). Timber harvest following fire may have an additive effect on watershed runoff not observed in areas subject only to wildfire (Megahan 1983). Wildland fires are a source of large wood recruitment to streams (Bêche et al. 2005, Robinson et al. 2005), and woody debris may be mobilized and redistributed along streams following fires (Young 1994).

Planned fire ignition (prescribed fire) is a tool used to modify existing vegetation or reduce excess fuel loadings that would otherwise contribute to uncharacteristic fire conditions (Mitchell et al. 2009). In most of the forested areas of the western U.S., including the Blue Mountains, the role of fire in forest ecosystems has been altered by fire suppression and other management activities since about 1900 (Hessburg and Agee 2003, Heyerdahl et al. 2001). Fire exclusion may have provided near-term protection from the effects of uncharacteristic wildfires to local watersheds but has also led to accumulation of fuels that increase the risk of high severity fire. Studies of year-to-year variability and seasonality of wildfires in the western U.S. also show the close association of climate conditions and the severity and extent of wildfires in the western U.S. (Littell et al. 2009, Westerling et al. 2003). Projected changes in temperature and precipitation for the Pacific Northwest are expected to increase the risks associated with high severity fires and increase the area burned by 2 to 3 times by the 2080s (Littell et al. 2010).

Prescribed fire is often used either alone or in conjunction with forest thinning to reduce wildland fire risk (Graham et al. 2004, Agee and Skinner 2005). Prescribed fires and thinning may be used together in areas where high fuel accumulations exist due to long-term fire exclusion (Harrod et al. 2009). Research shows that the most effective method to reduce fire severity is to use prescribed fire in conjunction with forest thinning (Covington et al. 1997, Graham et al. 1999). Most prescribed fires are ignited under conditions that limit the potential for high severity fires (Wondzell 2001), and prescribed fires typically have less effect on soil organic matter and soil structure and result in lower risk of soil erosion compared to higher severity fires (De Bano et al. 1998). Management actions associated with prescribed fires that disturb the soil profile, such as mechanical fuel treatment, reopening roads for access to harvest sites, or construction of fuel breaks, may result in increased erosion risk. In recent years, the widespread occurrence of high severity fires has resulted in increased emphasis on finding ways to reduce potential fire severity in riparian areas (Elliott et al. 2010).

From 1960 through 1979, an average of 4,400 acres per year were affected by wildfires in National Forest System lands in the Blue Mountains, compared to an average of 26,500 acres per year from 1980 through 2000. A total of 445,000 acres were affected by lightning-started fires from 1985 through 1994.

It is of interest in this analysis that 62 of 259 (24 percent) PACFISH-INFISH Biological Opinion monitoring reference streams have experienced large fires within approximately the last 30 years, but only 22 of 294 (7.5 percent) managed streams in the Blue Mountains have experienced fires during the same time period. This difference appears related to differences in fire suppression

strategies between managed and reference watersheds, and as will be explained later, has implications for the condition of riparian areas, stream channels, and aquatic habitats.

Livestock Grazing

Livestock grazing is among the most widespread land uses in the interior Pacific Northwest (Kauffman and Krueger 1984). Effects of livestock grazing include trampling, soil compaction, and loss of vegetative cover on both upland and riparian sites (Platts 1991). The degree of the effect depends on the intensity of grazing. Historically, degraded range conditions due to heavy livestock grazing were recognized before 1900. Skovlin (1991) estimated that livestock numbers were reduced by about half between 1900 and 1910, following the establishment of the Blue Mountains Forest Reserve. McIntosh (1992) reported that livestock numbers in the upper Grande Ronde River were reduced from 211,000 animal unit months in 1911 to 51,000 animal unit months in 1990, compared to 18,250 animal unit months in the same area as of 2013. Present (2013) livestock numbers represent a 96 percent reduction from 1900 levels and 91 percent reduction from levels at the time the national forests were established.

Heavy grazing can result in increased erosion and runoff from the breakup of soil crusts (Blackburn 1983). Overuse in riparian zones can affect stream bank stability, may cause changes in channel form (widening), and reduces resistance to floods (Marston 1994). Soil compaction from hoof impacts by livestock could result in reduced water infiltration and increased surface erosion Kauffman et al. (2004), but the extent of soil compaction depends on the grazing system (Walker and Heitschmidt 1986) and the duration of grazing. Recovery of compacted soils can occur within one year following the cessation of grazing, depending on soil site characteristics, the duration of grazing, and other factors (Wheeler et al. 2002), but sites that were heavily grazed historically or that have been grazed over multiple decades are likely to recover more slowly.

While livestock grazing has effects on uplands, the focus of this section is on potential or likely effects to riparian, stream, and aquatic habitats because of the sensitivity of these areas and their preferential use by domestic livestock.

Riparian areas of the western United States typically comprise one to two percent of summer range, but provide 20 percent of available forage (Clary and Webster 1990). Riparian vegetation provides several key functions in stream ecosystems, including the provision of shade, bank stability, nutrient transfer, retention of organic material, and source of woody debris (Gregory et al. 1991). Overuse of riparian vegetation by domestic livestock is likely a factor in the decline of riparian shrubs along interior Pacific Northwest streams (Lee et al. 1997). McIntosh et al. (1995) noted that deteriorated range conditions in the Columbia River Basin were documented before 1900 and that management practices improved after the national forests were established in the early 1900s.

Impacts of livestock grazing are potentially greater in riparian zones because they are used preferentially by livestock due to the availability of shade, water, and more succulent vegetation (Bryant 1982, Platts 1991). Brookshire et al. (2002) suggest that relatively light levels of livestock grazing, combined with intense wild ungulate browsing, can affect plant structure and limit reproduction of riparian willows. Holechek et al. (2006) suggested that adverse effects of grazing are avoidable if use intensity, expressed as a percentage of long-term average forage production, did not exceed about 40 percent. Elmore (1992) suggests that stream and riparian habitat conditions can improve with proper grazing management.

Changes in grazing management, such as rest, implementation of rest-rotation grazing schemes, reduced livestock numbers, and adherence to forage utilization standards, have led to improved range, riparian and stream channel conditions (Gifford and Hawkins 1976, Elmore 1992, Nagel and Clifton, 2003). Changes in grazing practices in the 1930s, 1950s, and since 1970, have likely improved range conditions across the Blue Mountains national forests compared to conditions in the early 1900s.

Additional measures restricting the management of livestock in National Forest System lands were implemented following the establishment of PACFISH and INFISH guidelines in 1995, which were intended to provide protection for anadromous and resident fish, riparian areas, and water quality. For example, the majority of perennial streams on several allotments were fenced to exclude or restrict livestock access, and monitoring data indicate that some riparian and channel attributes have improved in the Blue Mountains (Archer et al. 2009).

Livestock grazing may result in long-term impacts to aquatic systems, especially from changes in ground cover, shifts in species composition, and changes in sedimentation rates that are difficult to discern because streams are dynamic and variable (Platts 1991). In addition, degraded stream channels may remain in relatively poor condition long after the original impact because changes in stream channel conditions may make these streams more susceptible to damage from subsequent floods, making it difficult to identify the principal cause of degradation. Maloney et al. (1999) reported elevated stream temperatures in intensively grazed watersheds in the John Day basin, and the lowest stream temperatures were observed in ungrazed watersheds, but results were confounded by 100 years of prior grazing history.

Beaver were historically abundant in parts of the Blue Mountains (Cline 1988). The contributions of beaver dams in small streams are similar to the functions often attributed to large woody debris in larger streams (Pollock 2003). Beaver dams are sources of organic material to streams and are sites of nutrient retention that can greatly increase stream productivity (Naiman et al. 1986, Naiman et al. 1994). Beaver dams dissipate stream energy and provide channel stability (Gurnell 1998). They also create habitat diversity that benefits numerous other species (Pollock et al. 1995, Snodgrass 1997, Wright et al. 2002). The presence of livestock in areas of potential beaver habitat produces competition for limited food resources (Marston 1994) and can disrupt beaver-willow mutualism that occurs in less competitive environments (Baker et al. 2005). Riparian management practices that favor shrub production also favor the positive benefits of beaver-created landscapes (Munther 1982).

About 42 percent of the National Forest System lands in the Blue Mountains are suitable for sheep or cattle grazing. This includes 1.3 million acres within the Malheur National Forest (81 percent of the national forest), 344,000 acres within the Umatilla National Forest (25 percent of the national forest), and nearly 433,000 acres within the Wallowa-Whitman National Forest (24 percent of the national forest).

Active livestock grazing allotments total 3,255,000 acres on the Blue Mountains national forests and support 288,100 animal unit months, for an average 11.6 acres per animal unit month.

Some livestock grazing occurs within 455 of 552 subwatersheds within National Forest System lands in the Blue Mountains. In order to evaluate relative levels of livestock use within the national forests, available estimates of forage production by vegetation type from Countryman and Justice (2010) were compared to forage use based on stocking levels as of 2013. Use intensity was then compared to use categories by Holechek (2006) who suggested that good range conditions could be maintained with average forage use of 40 percent or less of forage

production. Calculations of total forage production by Countryman and Justice (2010) were summed for individual subwatersheds. The area of active allotments, suitable acres, and permitted animal unit months was determined for each subwatershed and the ratio of annual forage use to average forage production was calculated. The forage use criteria of Holechek (2006) may not be strictly accurate for the Blue Mountains, but the method allows for comparison of the relative differences in livestock use by alternative. Based on the above estimates of forage use and forage production, the average forage use by livestock is estimated to be 24 percent of annual forage production on the Malheur National Forest, 11 percent on the Umatilla National Forest, and 21 percent on the Wallowa-Whitman National Forest. Across all three National Forests, livestock use an estimated 18 percent of average forage growth annually. This analysis focuses on the relative effects of livestock on vegetation as vegetation use is arguably the most noticeable effect of livestock grazing.

Watershed Restoration and Monitoring

Aquatic and riparian habitat conditions within reference and managed watersheds have been monitored since 2001 as part of the PACFISH-INFISH Biological Opinion Monitoring Program (Archer et al. 2009). A comparison of average values for reference sites in the Columbia River Basin and managed sites in the Blue Mountains reveals that managed sites, on average, have higher pool frequency than reference sites (64.8 pools per kilometer vs. 43.1), but pools in reference sites are deeper (residual pool depth 0.41 meters versus 0.28 meters). Bankfull width-to-depth ratio and bank stability are nearly equal in managed and reference reaches; bank angle is higher in managed reaches and the percentage of undercut bank is lower in managed reaches; large wood frequency and volume are both significantly higher in reference reaches than in managed reaches (Table 165).

Table 165. Average values for PACFISH-INFISH Biological Opinion reference (n=259) and Blue Mountains managed (n=294) monitoring sites

Type of monitoring site	Pool depth (meters)	Pools per km	Pool percent	Bankfull W/D	Percent fines < 6 mm	Undercut Bank percent	LWD (no. per km)	LWD volume (m^3/km)
Reference	0.41	43.1	39.0	16.9	18.6	37.8	471.2	163.6
Managed	0.28*	64.8*	37.0	16.8	28.0*	23.6*	205.4*	89.4*

*denotes significant difference at 90% confidence level;
LWD = large woody debris; W/D = width-to-depth ratio

Recent reports for the Malheur, Umatilla, and Wallowa-Whitman National Forest (Archer and Ojala 2016a, 2016b, 2016c) report the present status of eight attributes compared to reference values and trend of 10 attributes for managed sites on each national forest.

On the Malheur National Forest (Archer and Ojala 2016a), habitat index is significantly lower in managed sites (24.1) than in reference sites (52.2), but improved between 2001-2005 (time 1, the first round of sampling) and 2006-2010 (time 2, the first repeat sampling). Values for residual pool depth, percent pools, median substrate size, substrate fines, large wood frequency, bank angle, and O.E. score (a measure of aquatic insect health), are all statistically different from reference sites. Habitat Index, Undercut bank percent, large wood frequency, bank angle and residual pool depth have all improved significantly between time 1 and time 2.

On the Umatilla National Forest (Archer and Ojala 2016b) the average values of all eight habitat attributes are significantly different at managed sites compared to reference sites. Large wood frequency is the only habitat attribute that improved significantly from time 1 to time 2.

On the Wallowa-Whitman National Forest (Archer and Ojala 2016c) average values of habitat index, residual pool depth, percent pools, large wood frequency, bank angle, and O.E. score are significantly different from reference values. Managed values for median substrate size and substrate fines are lower than reference values, but not significantly. Managed values for habitat index, percent undercut bank, large wood frequency, bank angle, and residual pool depth all improved significantly between time 1 and time 2. The percentage of substrate fine sediment increased slightly, and percent pools decreased, but not significantly. Three remaining attributes, O.E. score, bank stability, and median substrate size improved slightly, but not significantly.

Similar data are available for some individual subbasins, but not all subbasins, so are not used in this analysis.

Water Quality

Water produced within the Blue Mountains national forests is generally of high quality. Monitoring programs include an extensive network of stream temperature sensors, sediment sampling in selected streams as part of project monitoring, and measurements of other water quality parameters. The most persistent and widespread water quality concern for all three National Forests is high stream temperatures during low stream flows in summer. High summer air temperatures, decreased stream surface shading, low flows, and possibly changes in channel morphology, are important factors contributing to warmer water. Sediment levels in streams vary significantly with stream flows, with the highest levels during winter and spring runoff. Some stream reaches show evidence of sediment accumulation from varying sources, such as local stream bank erosion or contributing watershed conditions (such as erodible geology and roads close to streams). Sediment accumulation is a natural function in lower gradient streams, but some areas show evidence of sediment accumulation from past and ongoing management activities. Hazardous substances associated with mine discharge were identified in some streams in highly mineralized areas with past mining. These areas include the Granite, Burnt, and Upper North Fork John Day River watersheds within the Wallowa-Whitman and Umatilla National Forests and the Upper Middle Fork John Day River watershed within the Malheur National Forest. Other water quality concerns include nutrient and bacteria sources from livestock, wildlife, and recreation uses. Impacts generally occur during times of concentrated use (at concentrated use areas).

Water quality has improved in recent years due to changes in management motivated by direction in PACFISH and INFISH, implementation of water quality best management practices, direction in the Regional Aquatic Restoration Strategy, fish recovery plans, and through partner investments. Examples include increased emphasis on protecting streamside areas to reduce impacts to shade producing vegetation, repairing or removing unstable roads, and diverting mine discharge into off-stream settling ponds. At the project level, Forest Service staff design and implement a wide variety of best management practices as part of land management activities. Monitoring occurs on a sample of practices to determine implementation and effectiveness of best management practices and need for adjustment. For example, Umatilla National Forest personnel monitored salvage logging best management practices from 2006 through 2008 and reported adequate riparian areas, roads practices, and water quality protection. Monitoring of road decommissioning and stabilization conducted by the Rocky Mountain Research Station since

2008 has assessed treatment effectiveness in reducing impacts to aquatic ecosystems. Monitoring results indicated treatments reduced erosion and sediment delivery and lowered risk to aquatic ecosystems.

Impaired Waters

Water quality is compared to criteria for designated beneficial uses as defined by the Oregon Department of Environmental Quality and Washington Department of Ecology. Under section 303(d) of the Clean Water Act, states, territories, and some American Indian Tribes are required to develop lists of impaired waters submitted to Congress every two years. Streams that do not meet water quality criteria and thereby do not protect designated beneficial uses are impaired and are included on state 303d lists. The Clean Water Act requires that states develop total maximum daily loads (TMDLs) for these waters that address the sources of pollution and identify actions needed to improve water quality. A total maximum daily load is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. Total maximum daily loads establish load allocations that would provide conditions that meet State water quality standards over time.

Oregon Department of Environmental Quality's 2004/2006 water quality assessment was initially used to compile the list of impaired waters for Oregon for use in this analysis. For streams in Washington, the listing of impaired waters as of 2008 was used in this analysis. For the Blue Mountains, for all ownerships in subbasins with National Forest System lands, about 4,500 miles of streams were identified on state 303d lists as water quality limited. About 1,240 miles (492 stream segments in Oregon and 5 segments in Washington), or one-third of impaired stream miles, are located within national forests. This includes 464 miles within the Malheur National Forest, 326 miles within the Umatilla National Forest, and 454 miles within the Wallowa-Whitman National Forest. The most common water quality impairment in National Forest System lands is stream temperature. Other parameters for listing streams include sedimentation, turbidity, and nutrient, bacteria, and iron content. Because the concentration of dissolved oxygen in water is temperature dependent, streams with high water temperatures often have correspondingly low dissolved oxygen levels, which is detrimental to beneficial uses (cold water fish species).

In 2006, the Oregon Department of Environmental Quality and Washington Department of Ecology identified approximately 4,500 stream miles as water quality limited on state 303(d)) lists within subbasins with National Forest System lands in northeast Oregon and southeast Washington. Of this approximately 1,240 stream miles (28 percent) are located on the national forests in the Blue Mountains.

In 2012, the year of the most recent reporting, 1,226 stream miles were listed as water quality limited, TMDL needed (Category 5) on the three National Forests (Malheur 388 miles; Umatilla 492 miles; Wallowa-Whitman 679 miles). Of the water quality limited streams, 1,558 miles occurred in river basins in which Total Maximum Daily Loads have been approved (Category 4A), for a total of 2,784 stream miles listed as water quality limited on the national forests (Malheur 789, Umatilla 821, Wallowa-Whitman 1,173). The sum of Category 4A and 5 stream miles represents about 9 percent of total stream miles on the three National Forests, but 30 percent of perennial stream miles.

More streams are water quality limited because of stream temperature (1,494 miles, 54 percent) than for any other pollutant. Nine percent of streams (293 miles) have been listed for sedimentation, and 13 percent of streams (450 miles) have been listed for either biological criteria (395 miles) or *E. coli* (75 miles). Low dissolved oxygen levels are a pollutant in 238 stream

miles. Arsenic, copper, and mercury exceed water quality criteria in 20, 39, and 85 stream miles, respectively (Table 167 and Table 168).

Table 166. Miles of water quality impaired, TMDL needed (303(d)) stream by subbasin within each national forest as of 2012 (OR) and 2010 (WA)

Subbasin	Malheur	Umatilla	Wallowa-Whitman	303(d) Miles in National Forest System Lands
Upper Malheur	81	NA	NA	81
Brownlee	NA	NA	42	42
Burnt	NA	NA	98	98
Powder	NA	NA	99	99
Hells Canyon	NA	NA	65	65
Imnaha	NA	NA	29	29
Lower Snake - Asotin	NA	8 (WA)	12	12
Upper Grande Ronde	NA	1	24	25
Wallowa	NA	NA	46	46
Lower Grande Ronde	NA	18	35	53
Walla Walla	NA	15	NA	15
Umatilla	NA	1	NA	1
Willow – Middle Columbia	NA	5	NA	5
Upper John Day	46	NA	NA	46
North Fork John Day	5	271	44	320
Middle Fork John Day	47	NA	NA	47
Lower John Day	3	19	NA	22
Harney-Malheur Lakes	13	NA	NA	13
Silvies	110	NA	NA	110
Silver	96	NA	NA	96
Totals	**402**	**330**	**495**	1,226

Table 167. Category 4A water quality limited, TMDL approved stream miles by pollutant for each National Forest*

Pollutant	Malheur	Umatilla	Wallowa-Whitman	Total
Aquatic Weeds or Algae	NA	1.0	NA	1.0
Biological Criteria	6	NA	NA	6
Dissolved Oxygen	NA	NA	27	27
E. Coli	24	NA	NA	24
pH	NA	1	29.0	30
Sedimentation	NA	43	103	147
Temperature	357	446	454	1,256
Total Dissolved Gas	NA	NA	65	65
Totals	**388**	**492**	**679**	**1,558**

NA = not applicable; TMDL = Total Maximum Daily Load

* Source: Oregon Department of Environmental Quality 305(b) report (2012)

Table 168. Category 5 water quality limited, 303(d) list, TMDL approved stream miles by pollutant for each National Forest*

Pollutant	Malheur	Umatilla	Wallowa-Whitman	TOTAL
Arsenic	12	NA	8	20
Biological Criteria	199	96	94	389
Copper	NA	NA	39	39
Dissolved Oxygen	36	144	31	211
E. Coli & Fecal Coliform	NA	1	41	42
Iron	NA	1	NA	1
Mercury	NA	NA	85	85
pH	NA	38	17	54
Sedimentation	33	50	64	146
Temperature	122	NA	115	237
Turbidity	NA	NA	2	2
Totals	**402**	**330**	**494**	**1,226**

NA = not applicable; TMDL = Total Maximum Daily Load

* Source: Oregon Department of Environmental Quality 305(b) report (2012)

Sources of temperature impairment identified in TMDLs by Oregon Department of Environment of Environmental Quality and Washington's Department of Ecology include loss of stream shade, changes in channel morphology, loss of floodplain and shallow groundwater connection, and changes in streamflow. Both agencies recognize that stream shade provided by riparian vegetation has the most widespread achievable effect on reducing stream temperatures by reducing direct solar radiation. This emphasis on shade shows the importance of restoring healthy communities of riparian vegetation. The agencies recognize that changes in channel morphology are often more costly and take longer to achieve results. Oregon and Washington both recognize the role of flow depletion in elevating stream temperature and have administrative procedures for transferring water rights from out-of-stream uses to instream flows for benefit of water quality, aquatic species, and recreation uses when water rights are available for transfer. In addition both Oregon and Washington claim instream flow water rights for periods in which water is available (e.g. Cooper 2002).

As of 2010, the Oregon Department of Environmental Quality and Washington Department of Ecology have completed analysis of TMDLs and Water Quality Implementation Plans for the John Day, Upper Grande Ronde, Lower Grande Ronde, Tucannon, Walla Walla, Umatilla, Willow (Oregon), Malheur, and Snake River-Hells Canyon basins (see Table 169). The Total Maximum Daily Load (TMDL) process was initiated in the Deschutes-Crooked, Burnt, Powder, and Brownlee subbasins in 2010 and has not yet been started for Silver Creek or the Silvies River. Completed Total Maximum Daily Loads identify the sources of water quality impairment and the measures needed to restore water quality in each basin. The Forest Service has contributed to the development of TMDL analyses since 1998 by providing relevant data and technical assistance for streams within national forests in the Blue Mountains and has participated in technical and stakeholder groups. As the designated management agency, the Forest Service is responsible for developing water quality implementation plans that outline the best management practices and restoration strategies needed to restore water quality in impaired waters and reduce pollution to surface waters in National Forest System lands. This information is incorporated into watershed restoration plans which are currently being implemented in 3 watersheds and 22 subwatersheds.

Table 169. Status of total maximum daily loads (TMDLs) and water quality restoration plans (WQRPs) as approved or determined by Washington Department of Environmental Quality (WDOE) or Oregon Department of Environmental Quality (ODEQ)

National Forest	Subbasin/ Watershed	Water Quality Concern Addressed	TMDL Parameters	TMDL Date	WQRP Date	WDOE or ODEQ Response/Approval
Umatilla	Lower Snake-Tucannon (WA)	Temperature	Temperature	2010	None	WDOE included Federal land management requirements in streamlined process, FS not part of TMDL, provided data and comment
Umatilla	Walla Walla Basin (OR)	Temperature	Temperature	2005	2007	ODEQ provided comment on 303(d) listed (pre-TMDL) WQRP. 1 TMDL WQRP in preparation in cooperation with DEQ, TMDL completed
Umatilla	Umatilla River Basin (OR)	Temperature, pH, sedimentation, turbidity, aquatic weeds, algae	Temperature, pH, Sedimentation, Turbidity, Aquatic Weeds, Algae	2001	None	No 303(d) listed (pre-TMDL) WQRP submitted. No WQRP implementation plan required, TMDL completed
Umatilla	Willow Creek Subbasin (OR)	Temperature, bacteria, and pH	Temperature, Bacteria, and pH	2007	None	No WQRP submitted, TMDL completed
Malheur Umatilla Wallowa-Whitman	John Day Basin (OR)	Temperature, bacteria, dissolved oxygen, and excessive amounts of fine-grained streambed sediment.	Temperature, Bacteria, and DO	2010	In progress	No 303(d) listed (pre-TMDL). TMDL completed, WQRP in development.
Malheur	Malheur River Basin and Middle Snake-Payette Subbasin (OR/WA)	Temperature, bacteria, Chlorophyll-a, toxics, DDT, Dieldrin, and dissolved oxygen	Temperature, Bacteria, and Chlorophyll a (Controls on total phosphorus).	2010	In progress	TMDL completed, WQRP in development.
Umatilla Wallowa-Whitman	Upper Grande Ronde Subbasin (OR)	Temperature, pH, algae, dissolved oxygen, sedimentation	Temperature, Sediment, Nitrogen, Phosphorous	2000	None	No 303(d) Listed (pre-TMDL) WQRP Submitted, TMDL Completed
Umatilla Wallowa-Whitman	Lower Grande Ronde, Wallowa, Imnaha Subbasins	Temperature, bacteria (*E Coli* and fecal coliform), pH, dissolved oxygen, and sedimentation	Temperature, and Bacteria (E Coli and Fecal Coliform)	2010	None	No 303(d) listed (pre-TMDL) WQRP submitted. No WQRP TMDL Implementation Plan Required, TMDL Completed
Wallowa-Whitman	Snake River/Hells Canyon (part 1)	Temperature, total dissolved gas, DDT, DDE, DDD, Dieldrin	Temperature, Total Dissolved Gas, DDT, DDE, DDD, Dieldrin	2004	None	No WQRP Submitted, TMDL Completed
Wallowa-Whitman	Snake River/Hells Canyon (part 2)	Phosphorus, sediment and dissolved oxygen	Phosphorus, Sediment and Dissolved Oxygen	2004	None	No WQRP Submitted, TMDL Completed
Wallowa-Whitman	Powder Basin, Brownlee Reservoir Subbasin	not applicable	not applicable	not applicable	not applicable	TMDL not started (minimal or no activity)

The majority of waterbodies within the Blue Mountains national forests support designated beneficial uses, which include domestic and agricultural uses, cold-water fisheries, recreation, domestic livestock, and wildlife uses. Maintaining the quality of these waters is becoming increasingly important as the demand for clean water resources increases and the timing and volume of surface runoff changes in responses to climate change.

The ability to maintain existing high quality habitats and to restore degraded habitats will be influenced by climate change over the next several decades with projected higher average air temperatures, more winter precipitation falling as rain versus snow, and diminishing winter snow packs resulting in earlier reduced snowmelt runoff. Changes in runoff volume and lower summer base flows, higher surface water temperatures, and likely greater year-to-year variability in precipitation could also result in extended drought periods and more severe floods than have occurred in recent history. Changes in timing and amount of runoff associated with climate change affect every resource, including terrestrial vegetation, wildlife, riparian and aquatic species, and water availability for human use. The effects of climate change to water resources are further described in the discussion of cumulative effects.

Water Uses

Water from the national forests is valued for many ecological, economic, and social purposes. Ecological values are described in the watershed function and water quality sections. Water uses may be consumptive and nonconsumptive uses for defined purposes recognized by Federal and State agencies. Consumptive use is water not returned to streams after use.

Within the national forests, water is used for a number of purposes including habitat for anadromous and resident fish species, domestic and municipal uses, commercial and industrial uses, Forest Service management, mining, irrigation, and other uses. By volume, the largest water uses are for instream flows for the maintenance of freshwater habitats, water quality or recreation (greater than 40 percent of total streamflow), and irrigation (20 percent). Instream water rights are held by several State agencies in Oregon and Washington.

Most of the water diverted within the national forests is used for agricultural uses on private lands downstream of National Forest System lands. Domestic and municipal water uses account for less than 2 percent of total water use. Out of 3,913 points of diversion within national forests in the Oregon portion of the Blue Mountains, 2,898 points of diversion (74 percent of Forest Service-owned water rights) provide water for domestic livestock and 607 points of diversion (16 percent of Forest Service rights) are used to provide water for wildlife. For all subbasins in the Blue Mountains, groundwater accounts for less than 10 percent of total water withdrawals and 95 percent of withdrawals are for irrigation.

Water use by livestock on the national forests, based on 290,000 animal unit months and water consumption of 30-45 gallons per day per animal unit month equates to annual water consumption of 800-1200 acre feet or 0.02 percent of annual streamflow, and less than 0.2 percent of June through September streamflow. Consumptive use of water for irrigation downstream of the national forests is 15 to 22 percent of annual streamflow. In the river basins where irrigated agriculture is most developed, summer water use is 50 percent to more than 90 percent of available stream flow, and estimated consumptive use of water exceeds 90 percent of streamflow for one or months of the growing season in six different subbasins.

Storage water rights within the national forests total less than 120,000 acre-feet and total reservoir storage within river basins in the Blue Mountains totals approximately 480,000 acre-feet and is

distributed across seven different river basins, not including the Snake River. For comparison, winter snow stores an estimated 3.5 to 4.2 million acre-feet of water that is released during a roughly 3- to 6-month period that begins in February at low elevations and extends into August at high elevations. The total amount of water withdrawn for public, domestic, commercial and industrial, livestock watering, and agriculture was roughly 2.3 million acre-feet in 1995 (Solley et al. 1998) and consumptive use (the amount not returned to streams) was roughly 1.3 million acre-feet, or 18 percent of annual stream flow from all area rivers. In 1995, about 8 percent of water withdrawals were from groundwater and the remainder from surface water.

Summer water use for irrigation downstream of the national forests accounts for about 96 percent of total water use, with the remainder used for public (2 percent), domestic (0.4 percent), industrial (0.8 percent), and livestock (0.4 percent). Irrigation water use accounts for 6 percent (April) to more than 60 percent (August) of monthly streamflow during the growing season. Consumptive use of water for irrigation averages about 9 percent of streamflow in April, May, and June, and ranges from 1 to 53 percent. Consumptive use of water for irrigation exceeds 50 percent of streamflow during July, August, and September, but exceeds 90 percent in six subbasins: Walla Walla, Umatilla, Willow-middle Columbia, Upper John Day, Silvies, and Silver. July through September water use exceeds 70 percent in the Burnt and Powder subbasins, and 65 percent in the Upper Grande Ronde subbasin. The percent of consumptive use in the Walla Walla and Umatilla subbasins may be lower than stated here because these basins have higher rates of groundwater use, and exchanges or transfers of water rights within each subbasin for water rights on the Columbia River may have occurred that lessen the demand for surface water withdrawals. All of the basins named here are water limited and vulnerable or highly vulnerable to decreases in water supply during droughts and the changes expected to occur with climate change.

Many communities in the Blue Mountains and surrounding areas rely on water from the national forests for their drinking water. National Forest System lands are the primary source of drinking water for the cities of Walla Walla, Pendleton, La Grande, Baker City, Long Creek, and Canyon City. Some communities have municipal water rights in National Forest System lands but currently use other sources. By state law, in Oregon and Washington, municipal water rights do not lapse for non-use, and communities retain the right to develop these sites in the future if they choose to do so.

Many smaller community or individual water systems have sources within National Forest System lands. In Oregon, there are 230 points of diversion within National Forest System lands and an additional 70 points outside National Forest System land but within the proclaimed boundaries of the national forests that provide water for domestic use. In the Washington portion of the Umatilla National Forest, there are an additional 20 diversion points that provide water for domestic use. Campgrounds and administrative sites operated by the Forest Service, in addition to public and domestic water sources, are located throughout the national forests and private lands within the boundaries of the national forests so that the majority of watersheds within the national forests provide some water for domestic or municipal use.

Of approximately 8,300 water rights within the proclaimed boundaries of the national forests, 3,200 (39 percent) provide water for domestic livestock, 2,210 (33 percent) support instream flows, 580 (9 percent) provide water for wildlife, 680 (8 percent support irrigation uses), and 280 (3 percent) provide water for domestic and municipal uses. There are 122 water rights used in mining operations, including aggregate (gravel) mining. There are 348 (4 percent) water rights associated with forest management, not including campgrounds.

Under State law, instream flow water rights can only be held by State agencies. Oregon has been active in claiming instream rights, but the majority of these rights are for discrete periods of time, usually 2 weeks or less, when water is available according to water availability studies by the Oregon Water Resources Division (Cooper 2002). Water rights for livestock grazing on the national forests represent the largest percentage of federally owned water rights. However, total water use by livestock on the national forests, using an estimate of 290,000 animal unit months, is estimated at only 800 to 1,200 acre-feet per year, or 0.013 to 0.02 percent of total streamflow, and less than 0.2 percent of summer streamflow, although this percentage may vary in different watersheds.

Analysis Assumptions and Methods

Alternatives

All alternatives include desired conditions for watershed function and water quality, as displayed in Appendix A and the 2018 Aquatic and Riparian Conservation Strategy (ARCS). Alternatives E and F include desired conditions for road density in watersheds with anadromous fish and bull trout. Allowed forage utilization by livestock varies by alternative. Livestock grazing would be most restricted in Alternative C, because livestock use would not occur in watersheds with federally listed fish species. Livestock grazing in Alternatives E-Modified and E-Modified Departure could occur in currently vacant allotments, contingent on the completion of site-specific environmental analysis of the affected allotments. Elements of the 2008 Regional Aquatic and Riparian Conservation Strategy (USDA Forest Service 2008) are included in Alternatives B, C, D, E, and F, but alternatives differ in some desired conditions, standards, and guidelines and in their emphasis on riparian areas and level of watershed restoration.

The ARCS was updated in 2018 and incorporated into Alternatives E-Modified and E-Modified Departure. The 2018 Blue Mountains ARCS preserves elements of PACFISH and INFISH intended to provide for consistent management for the benefit of aquatic and riparian-dependent species across all national forests in the Pacific Northwest Region.

The 2018 Blue Mountains ARCS elements include:

- Riparian management areas
- Key watersheds
- Mid-scale, or watershed analysis
- Watershed restoration
- Monitoring

These elements are intended to work together to achieve a distribution of watershed conditions that are resilient to natural disturbance and that maintain, restore, and enhance habitat for resident and anadromous fish and other aquatic and riparian dependent organisms (USDA Forest Service 2008, 2016).

As described in the proposed action, desired conditions are developed specifically for riparian management areas, watersheds, stream channels, and aquatic habitats. Most desired conditions are intended to apply to all watersheds, although some desired conditions apply specifically to key watersheds. A subset of key watersheds are identified as a priority for restoration within each national forest, recognizing that limited restoration funding would be focused on the highest priority watersheds and essential work would continue until completed.

The intent of the 2018 Blue Mountains ARCS is to accelerate improvement of watershed and aquatic/riparian conditions across the Blue Mountains by (1) conducting new and ongoing management activities in a manner that, across broad scales, protects areas in good condition and allows for passive recovery of those that are degraded, and (2) actively restoring watershed conditions in high-priority areas by implementing integrated, strategically focused restoration treatments that facilitate the recovery of critical watershed processes (Sedell et al. 1997).

Riparian management areas are areas bordering perennial and intermittent streams, wetlands, and sensitive areas (i.e., ponds, lakes, wetlands, seeps, springs, unstable slopes) where the management emphasis is to maintain, restore, or enhance the ecological health of aquatic and riparian ecosystems. The complete definitions of riparian management areas and criteria under which they are applied can be found in the glossary.

Key watersheds are subwatersheds, or groups of subwatersheds, selected to serve as strongholds for important aquatic resources or that have the potential to do so. Key watersheds have a combination of watershed, riparian and aquatic habitat conditions that support, or are capable of supporting, strong populations of one or more selected surrogate species (Chinook salmon, steelhead, inland redband trout, and bull trout). A subset of key watersheds are named as priority watersheds and are expected to be the focus of watershed-related restoration over the life of the revised forest plan. The criteria and methods for selection of key and priority watersheds and tables identifying key and priority watersheds on each national forest are located in the 2018 Blue Mountains Aquatic and Riparian Conservation Strategy (Appendix A of each Forest Plan).

Mid-scale, or watershed analysis is a process for identifying and characterizing the status and trends of key physical and ecological conditions and processes influencing aquatic and riparian ecosystems at watershed scales, identifying the primary management issues associated with those conditions, and identifying opportunities to address them. Watershed analysis is not a forest plan component, but is an important process for informing forest plan implementation, as it provides context for management activities. The results of watershed analyses are used to diagnose the status and trend of aquatic and riparian resources; tailor and/or refine broad-scale desired conditions to finer scales; establish watershed-scale objectives for aquatic and riparian resource management; identify key management needs and opportunities, including restoration; and develop local monitoring programs. Watershed analysis provides the basis for developing watershed restoration programs and implementing a diverse range of land management activities in a manner that protects and/or enables natural recovery of watershed conditions.

Watershed restoration is an integrated set of both passive and active measures intended to facilitate the recovery of the physical, biological, and chemical processes that promote the maintenance or recovery of riparian and aquatic ecosystem structure and function. Implementation of the watershed restoration element would be tiered to the 2005 Regional Aquatic Restoration Strategy (USDA Forest Service 2005), which uses a strategic, integrated, multi-scale approach to prioritize watershed restoration treatments. The highest priority is the restoration of critical watershed processes in those areas where the structure and function of the aquatic ecosystem are largely intact, but threatened by existing or projected watershed conditions. Watersheds with highly degraded aquatic ecosystems will be a lower priority for restoration until threats to existing strongholds (like key watersheds) are addressed.

The focus of restoration actions is to restore the processes responsible for creating and maintaining the landscape-scale diversity of aquatic and riparian habitats. Actions to accomplish this may include, but are not limited to:

- Altering the structure and composition of upland vegetation in order to move towards desired conditions, reduce wildfire risk, and restore resilience
- Increasing the diversity and complexity of aquatic and riparian habitats by promoting natural establishment and succession of riparian plant communities
- Restoring the natural range of stream flows to the greatest possible extent
- Reducing road-related erosion and sediment delivery to streams through road closure, road obliteration, improving maintenance, and/or improving erosion control
- Removing fish passage barriers that block or restrict access to historically occupied aquatic habitats or restrict connectivity between aquatic habitats
- Altering riparian habitats to favor deciduous trees and shrubs as appropriate and where such species were formerly abundant
- Reintroducing keystone species, such as beaver, into suitable habitats within their former range
- Designing watershed, riparian and aquatic habitat restoration projects that promote ecological function and the range of natural processes responsible for habitat formation
- Managing invasive species to maintain the composition and diversity of native species
- Adapting management actions to respond to the expected effects of climate change

Watershed Condition Framework (USDA Forest Service 2011a) formalizes the process of planning and implementing watershed restoration and the national forests. The framework incorporates a standardized methodology for assessing watershed conditions, and requires the national forests to name a limited number of watersheds as priorities for restoration. Watershed restoration action plans identify the essential restoration needs of individual watersheds. The framework calls for monitoring of the effectiveness of restoration actions and provides a mechanism for tracking the implementation and completion of restoration actions. Elements of the Watershed Condition Framework are incorporated into Alternatives E-Modified and E-Modified Departure, and are described in more detail in Appendix A of the Forest Plans.

Monitoring is a systematic, science-based process of collecting and analyzing information. There are three types of monitoring: implementation, effectiveness, and validation. Monitoring will determine whether management direction is implemented as intended, whether it is effective at achieving desired results, and the status and trends of particular ecological conditions or relationships. Monitoring is essential, as it provides the basis for determining whether forest plan components and/or their implementation need adjustment.

Appendix A includes a proposed framework for monitoring the revised Forest Plans. The components associated with watershed and aquatic resources are intended to do the following:

- At the project-scale, assess whether design criteria (standards and guidelines) are implemented and effective at achieving desired aquatic resource management objectives.
- At broader-scales, track the condition and trend of watersheds, aquatic and riparian habitats, water quality, and aquatic focal species and assess progress towards achieving or maintaining the associated desired conditions.

- Track implementation of proposed restoration actions and evaluate the effectiveness of those actions in improving watershed conditions, particularly in key and priority watersheds.
- Provide information on the effects of climate change on watershed resources, particularly changes in stream flows and stream temperatures.

Collectively, this multi-scale monitoring program is intended to facilitate management by providing relevant information over both short (years) and long (decadal or longer) timeframes. For example, in the short term, project-scale implementation and effectiveness monitoring will evaluate whether standards and guidelines are followed and/or whether they need to be modified to achieve desired conditions. Conversely, over longer timeframes, broader-scale status and trend information will be used to evaluate whether desired conditions, objectives, and/or land allocations require adjustment.

Watershed Function, Water Quality, and Water Uses – Environmental Consequences

Summary of Effects to Watershed Function, Water Quality, and Water Uses

This section introduces the environmental consequences of the alternatives and includes a general summary of broad scale effects and relative trends for the Plan Area followed by detailed discussion of the effects of each alternative for each National Forest. Site-specific outcomes to watershed function (hydrologic function, riparian and wetlands areas, streams, and aquatic habitat), water quality, and water uses from the alternatives are not predicable until mid-scale assessment and/or project level environmental analysis is completed.

Alternative A would continue current management direction, which includes a mix of protection strategies and active watershed and vegetation management. Watershed restoration would proceed at current levels. Although watershed restoration is not integral to forest plan direction as amended by PACFISH and INFISH, the emphasis on implementing watershed, stream channel and riparian habitat restoration projects has increased during the last 20 years. Current management direction includes forest and regional strategies for watershed protection and restoration. The emphasis on watershed protection and restoration in Alternative A would be slightly less than it would be for Alternatives B, E, and F, and much lower than for Alternative C, because of differences in the area of riparian habitat conservation areas for intermittent streams in watersheds where no listed fish species are present and because projections for restoration are reduced. Management direction in Alternatives E-Modified and E-Modified Departure would be similar to the other alternatives, would have the same riparian management area extent and key watershed network as Alternatives B, E, and F, but each would contain additional desired conditions for riparian, stream channel, and aquatic habitats, and would incorporate modified management direction, including standards and guidelines, for the management of roads, timber harvest, and livestock grazing.

Over the life of the plan (10 to 20 years), watershed conditions under Alternative A would be maintained or improved at current rates. During the long term (greater than 20 years), watershed conditions would continue to improve but at slower rates (fewer watersheds in improving condition) compared to Alternatives B, C, E, E-Modified, E-Modified Departure, and F because of differences in protection and restoration levels as described in the details of the alternatives. Protection of watershed-related resources in this and all other alternatives is implied by the width of riparian management areas or riparian habitat conservation areas, limitations on motor vehicle

use, road construction and other land disturbing actions, and the extent of management areas in which land disturbing activities would be limited.

Alternatives B, C, E, and F include Plan Area-wide strategies for watershed protection and active restoration that would likely result in accelerated improvement of watershed conditions and in maintenance or improvement of lakes, streams, and rivers at varying rates. These alternatives include consistent direction for seasonally flowing and intermittent streams across all watersheds. Alternatives E-Modified and E-Modified Departure include modifications of some elements of the Aquatic and Riparian Conservation Strategy incorporated into Alternatives B, C, E, and F, including reworded and additional desired conditions and standards and guidelines.

Alternative B includes a mix of protection and restoration proposals that would improve watershed conditions and water quality more than Alternative A but less than Alternatives C, E, and F during the short and long terms because of slightly lower projections for protection and restoration. Alternatives E-Modified and E-Modified Departure would incorporate much of the management direction incorporated into Alternatives, B, C, E, and F, and include enhanced management direction for watershed, riparian, stream channel, and riparian habitats. The rate of watershed-related restoration in Alternative E-Modified would be similar to Alternative E. The rate of watershed-related restoration actions in Alternative E-Modified Departure would be similar to Alternative F.

Alternative C would have the greatest level of watershed restoration and the largest contiguous areas of limited motor vehicle use. Alternative C would result in the greatest improvement in watershed condition during the short and long terms, in large part, because active restoration of riparian and aquatic habitats would be higher than in all other alternatives. Riparian management Area widths would be the widest of all plan revision alternatives (300 feet on all streams). There would less active management of vegetation and reduced areas open to livestock grazing. During the long term there would be an increased risk of disturbance associated with limited active vegetation treatment particularly in dry forest types that could result in reduced benefit to watershed condition.

Alternative D would emphasize commodity production and would have the lowest levels of watershed protection and restoration of hydrologic and riparian function. It would have the highest level of active vegetation management. Improving vegetation resilience would contribute to improved watershed condition but would likely result in a declining trend in overall watershed improvement and a potential for degradation of watershed condition, water quality, and soil quality in some areas because of relatively high objective levels for timber harvest, road use, and livestock grazing. Although upland vegetation conditions would improve at a fastest rate, this alternative would have the greatest short and long-term risks to watershed function and water quality. Alternative D would have the narrowest riparian management area widths, and would be the least protective of aquatic and riparian-dependent resources. However, in alternatives D, E-Modified and E-Modified Departure, there could be more opportunity for the treatment of hydrologically connected roads, resulting in greater reductions in road-related sediment delivery to streams that partially offsets other potential adverse effects.

Alternatives E and F include a mix of watershed protection and active restoration that would, during the short term, improve watershed conditions more than Alternatives B and D, but less than Alternative C. These alternatives include desired conditions for reduced road density in anadromous and bull trout watersheds and specific guidelines for range management that would, during the long term, contribute to improving trends in watershed condition and water quality in

affected watersheds. Alternative E would provide greater emphasis on vegetation restoration and, during the short term, pose slightly greater risk to watershed conditions (less than Alternative D but more than the other plan revision alternatives). During the long term, both alternatives would improve watershed conditions and water quality at a slightly lower rate than Alternative C because of the levels of protection and amount of active restoration, including vegetation and roads activities.

Alternatives E-Modified and E-Modified Departure would incorporate a modified Aquatic and Riparian Conservation Strategy with enhancements and additions to desired conditions, standards, and guidelines intended to benefit aquatic and riparian-dependent resources. The two modified alternatives would also incorporate the Watershed Condition Framework, which formalizes the assessment of watershed condition, prioritization of watersheds for restoration, requires the development and implementation of watershed restoration plans, and provides for monitoring of the effectiveness of restoration actions and tracking accomplishments. Alternative E-Modified Departure would accelerate timber harvest for a period of years with the intent of faster attainment of vegetation desired conditions that would be achieved by Alternative E Modified. Both modified alternatives would have similar restoration benefits, although the accelerated rate of upland vegetation management in Alternative E-Modified Departure would not be sustainable over multiple decades and would likely result in less benefit to watershed, aquatic, and riparian-dependent resources. Riparian management area widths in the modified alternatives are the same as in Alternatives B, E, and F.

All plan revision alternatives include key and priority watersheds as a basis for watershed protection and restoration, but effects to watershed function and water quality would vary in these areas because of different mixes of management area allocations, suitability, access (roads and trails), and other management activities. All alternatives would include water quality best management practices for protection and restoration of water quality as part of project-level design criteria. Water quality best management practices would apply in all watersheds but effectiveness would vary because of differences in riparian protection and activity levels. “Short term” refers to the life of the plan, or 10 to 20 years, and “long term” refers to effects beyond the life of the plan, or beyond 20 years, and assumes the alternative intent would continue into the future.

Effects of the alternatives are described in the following order for each national forest:

- Upslope conditions within watersheds are described in terms of expected changes in the condition of forested vegetation, hydrological connectivity of the road system, and livestock use intensity
- Differences in the effects of grazing on riparian habitats between alternatives
- Influence of differences in riparian habitat conservation areas and riparian management areas
- Influence of restoration actions on riparian, stream channel, and aquatic habitat conditions
- Extent of detrimental soil conditions resulting from expected levels of timber harvest
- Changes in overall watershed conditions, considering all of the above factors
- The expected influence of differences in management direction between alternatives

Comparison of Alternatives

Malheur National Forest

Key Indicator: Vegetation Condition

Vegetation condition in this analysis is the percent departure from desired conditions on a scale of 0 to 100, with 100 being the most departed from desired conditions and poorest condition. Vegetation departure compares existing and modeled future conditions for each forest potential vegetation group to the desired condition for six structural stages and age classes, as described in the Forest Vegetation and Ecological Resilience sections of this document. Vegetation departure was calculated in ten-year time steps to 80 years. Departure values for existing conditions, 10 years, and 20 years used in this analysis display conditions over the expected life of the forest plan and change from existing condition. Because the data is not spatial, departure is calculated for each combination of three potential vegetation groups (dry, cold, and moist forests) and four management strata: general forest, reserve, roadless, and wilderness based on assumptions of expected management activity and disturbance frequency. Departure scores are calculated for individual watersheds by summing the acres of each combination of potential vegetation group and management strata, then calculating an area-weighted departure score. Because departure values are an average for a given combination of potential vegetation group and management strata, actual vegetation departure in any given watershed may vary from that average.

Departure values of less than 33 are least departed from desired conditions; departure values greater than 66 are highly departed; departure values between 33 and 66 are moderately departed. The change in departure scores by decade depends on the relative abundance of each of 12 combinations of forest vegetation type and management strata. Because the departure scores are area-weighted averages of all 12 combinations, and there is at least one combination of vegetation type and management strata that declines at each time step between year 10 and year 80, it is possible that average scores go down from one decade to the next in some watersheds and for some alternatives. This may result from assumptions of the rate or magnitude of disturbance, assumptions of where and what types of vegetation management actions are expected to occur, or by a negative change in a single, abundant structural stage, or because of modeled declines in one of the three forest vegetation classes (for example moist forest on the Wallowa-Whitman National Forest).

Vegetation departure scores in this analysis are a measure of overall stand condition for both upland and riparian vegetation. Because water use by vegetation is the largest component of the water balance of forested watersheds after precipitation, it follows that changes in vegetation condition result in variations in water use by vegetation that ultimately affect stream flow. This analysis makes the simplifying assumption that desired vegetation conditions, are a reasonable approximation of desired or normative hydrologic conditions as influenced by forest vegetation. Departure scores are calculated and displayed separately for upland and riparian vegetation for existing condition (Time 0) and for years 10 and 20.

The percent area and average departure score of each of the three dominant forested potential vegetation groups within the Malheur National Forest are displayed in Table 170. Dry forest accounts for 72 percent of the Malheur National Forest and is currently the most departed from the historical range of variability. Note that, in this analysis, forest and riparian departure scores are based only on the three forest potential vegetation groups. On the Malheur National Forest, this represents 87 percent of the land base.

Table 170. Percent of national forest and average vegetation departure score by potential vegetation group for the Malheur National Forest

Potential Vegetation Group	Percent of Malheur National Forest	Average Vegetation Departure
Dry forest	72%	66
Moist forest	6%	53
Cold forest	9%	61

Table 171 displays average existing vegetation departure scores for all watersheds, priority watersheds, and key and priority watersheds combined and the expected average departure at year 10, by alternative. Table 172 displays the expected average departure scores at year 20.

Table 171. Average of subwatershed forest vegetation departure in all watersheds, priority watersheds, and in key and priority watersheds combined at year 10 for each alternative for the Malheur National Forest

Forested Vegetation Departure	Existing Condition	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep Yr. 10	Alt. F Yr. 10
All WS (143)	65.1	56.8	57.0	56.7	50.4	55.5	49.9	55.4	56.2
PWS (34)	64.8	54.1	54.8	53.2	47.6	53.2	46.9	53.1	53.9
KWS and PWS (62)	65.2	55.6	56.0	54.7	49.0	54.4	48.6	54.3	55.1

WS = watersheds; PWS = priority watersheds; KWS = key watersheds

Table 172. Average of forest vegetation departure in all watersheds, priority watersheds, and in key and priority watersheds at year 20 by alternative, Malheur National Forest

Forested Vegetation Departure	Alt. A Yr. 20	Alt. B Yr. 20	Alt. C Yr. 20	Alt. D Yr. 20	Alt. E Yr. 20	Alt. E-Mod. Yr. 20	Alt. E-Mod. Dep Yr. 20	Alt. F Yr. 20
All WS (143)	52.1	51.5	52.5	43.8	49.1	42.4	48.6	50.1
PWS (34)	48.6	48.6	48.5	40.5	46.3	38.5	45.3	47.1
KWS and PWS (62)	50.4	50.0	50.3	42.1	47.7	40.6	46.9	48.6

WS = watersheds; PWS = priority watersheds; KWS = key watersheds

At year 10, the greatest average improvement in forest vegetation condition on the Malheur National Forest would be achieved in Alternative E-Modified (all watersheds), followed by Alternative D, then Alternative E-Modified Departure. The least improvement in vegetation condition would occur in Alternatives B, A, C, and F, in that order. At year 20, the greatest improvement in vegetation condition is still expected in Alternative E-Modified, followed by Alternative E-Modified Departure, then Alternatives D, E, F, B, A, and C.

The reserve strata includes riparian areas, special areas, natural areas, and wild and scenic rivers. In general, the majority of acres in the stratum are in riparian areas. On this basis, vegetation departure for the reserve stratum is an approximation of the departure of forest vegetation in riparian areas from desired conditions. The average departure scores at year 10 and 20 are displayed in Table 173 and Table 174.

Table 173. Average riparian departure at year 10, Malheur National Forest

Riparian Vegetation Departure	Existing Condition	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep Yr. 10	Alt. F Yr. 10
All WS (143)	55.6	49.9	50.6	*54.1*	50.4	48.7	46.4	48.4	50.2
PWS (34)	56.3	44.3	49.0	*50.8*	47.8	43.4	44.8	47.1	48.9
KWS and PWS (62)	56.1	47.9	49.7	*52.4*	48.9	47.4	45.5	47.6	49.4

WS = watersheds; PWS = priority watersheds; KWS = key watersheds

Table 174. Average riparian departure at year 20, Malheur National Forest

Riparian Vegetation Departure	Existing Condition	Alt. A Yr. 20	Alt. B Yr. 20	Alt. C Yr. 20	Alt. D Yr. 20	Alt. E Yr. 20	Alt. E-Mod. Yr. 20	Alt. E-Mod. Dep Yr. 20	Alt. F Yr. 20
All WS (143)	55.6	48.4	47.7	*51.9*	47.0	44.5	40.1	43.4	47.0
PWS (34)	56.3	42.7	44.9	*47.9*	44.3	39.0	37.2	41.1	44.7
KWS and PWS (62)	56.1	46.6	46.1	*49.8*	45.4	42.8	38.5	42.1	45.6

WS = watersheds; PWS = priority watersheds; KWS = key watersheds

Riparian vegetation departure scores at year 10 would have the most improvement in Alternative E-Modified, E-Modified Departure, then Alternatives E, F, A, D, B, and C, in that order. At year 20, the lowest average vegetation departure would occur in Alternative E-Modified for all watersheds and in priority watersheds. Alternatives E and E-Modified would result in the most improved vegetation conditions in priority watersheds. The least improvement in riparian vegetation condition is expected in Alternative C, at year 10 and year 20.

Key Indicator: Roads

Two measures of roads, total road density and hydrologically connected roads, are used in this analysis. Forest road databases list the miles of open, closed, and decommissioned roads. Existing road miles in Table 175 consist of the sum of open and closed roads. These roads are currently part of the national forest road system. Decommissioned roads are roads that are no longer part of the forest road system. Miles of decommissioned roads are included in the sum of total roads in Table 175. The method of decommissioning can vary from barricading the road, ripping the road surface, to eliminating the road and restoring the original surface contour.

Total road miles represent the approximate road network that existed in 1990. Since then, 875 road miles, or 8.5% of the forest road system have been decommissioned, and 3,700 miles, or 36% of the forest road system, have been closed to motor vehicle use, and are considered to be in storage.

Lee et al. (1997) used road density as a measure of land use intensity based on the recognition that the presence of roads facilitates a variety of land uses that include, but are not limited to logging, motorized and not motorized recreation, and livestock grazing. This analysis identifies hydrologically connected roads as the roads that are most responsible for changes in watershed hydrology and road-related sediment delivery to streams. The extent of hydrologically connected roads is approximated by the miles of roads within 300 feet of streams.

Miles of existing, open, and closed roads are displayed in Table 175. This analysis uses total road miles to display the maximum possible effect of forest roads on watershed condition and displays road treatment objectives, miles of hydrologically connected roads, and channel network extension based on miles of existing roads. Decommissioned roads are included because the method of decommissioning is often unknown, or undocumented, and the condition of decommissioned roads is not certain. The inclusion of decommissioned roads affects both the calculations of road density and hydrologically connected roads. Within the Pacific Northwest Region, roughly 30 percent of decommissioned roads are untreated, up to 33 percent are recontoured, and the remainder treated by either tilling or ripping the road surface (Black et al. 2017). On this basis, it is expected that decommissioned roads to have less effect on watershed function than existing roads, and that some will have no effect. Similarly, closed roads should have less effect than open roads because they have less traffic. A preliminary analysis suggests that the condition of closed roads varies greatly, that some roads are overgrown with vegetation and have little effect on watershed runoff, but that some closed roads are severely eroded and still effect watershed hydrology. This analysis does not attempt to distinguish these differences because it cannot distinguish these local differences in road conditions.

Table 175. Miles of decommissioned, open, closed, existing, and total road miles on the Malheur National Forest (density for open, existing and total roads are in parentheses)

Decommissioned	Open	Closed	Existing	Total
875 (NA)	5,713 (2.14)	3,709 NA	9,423 (3.53)	10,298 (3.86)

NA = not applicable

The majority of forest roads were constructed in order to provide access for timber harvest. Harvest units have landings and skid trail networks in addition to forest roads. If road density is 4 miles per square mile and road surface width is 14 feet, roads occupy 1.1 percent of watershed area. Based on a preliminary analysis, skid trail networks may occur on 4 percent to more than 25 percent of individual harvest units, depending on local topography and vegetation type. Individual landings vary in size from about 0.33 to 0.75 acre. If average landing size is 0.5 acre and landings are 550 feet apart, then landings would occupy 3 percent of watershed area.

This analysis includes closed and decommissioned roads in the calculation of road density and hydrologically connected roads to account for the effect of skid trail and landings. This likely results in an over-estimation of the effect of roads in some watersheds, but may underestimate the effect in other watersheds. The magnitude of the difference is affected by the time since logging and the treatment, if any, of skid trails and landings to control erosion and reduce runoff. A review by Grant et al. (2008) suggests that the effect of roads on watershed runoff is affected by the location of roads relative to harvest units and that roads below clearcut units may have relatively higher impact. This analysis assumes that skid trails contribute to that additive effect.

Within the 143 subwatersheds modeled for the Malheur National Forest, there are 9,423 existing road miles for an average road density of 3.53 miles per square mile and 10,298 total roads miles (average road density 3.86 miles per square mile). The 34 priority watersheds within the Malheur National Forest contain 3,662 total road miles for an average road density of 4.27 miles per square mile.

An estimated 3,266 miles of hydrologically connected roads occur within the national forest, including 1,128 miles in priority watersheds. Adding stream miles and hydrologically connected

road miles indicates that roads may extend the channel network by an average 50 percent. Using only existing roads, channel network extension would be 50 percent across all watersheds and 55 percent in priority watersheds. Both numbers are higher than reported in available studies, but no reported study of hydrological connectivity has been conducted in watersheds in which average road density was as high as currently exists on the Malheur National Forest.

In this analysis, road density is held constant between alternatives, although the analysis is based on an assumption that road effects cannot be zero unless road density is also zero (meaning that some effects of roads remain as long as roads exist). The analysis assumes that hydrologic connectivity of forest roads can be reduced, not eliminated. Some road decommissioning or obliteration may occur in each of the alternatives, but the miles of road decommissioning cannot be predicted at this time. Some roads may be decommissioned where resource damage is highest and the effects cannot be mitigated by other means. This analysis assumes that road treatment objectives will be accomplished in priority watersheds first, then in other key watersheds.

Watershed objective levels were set based on in part on expected funding levels for the individual alternatives, the emphasis of the alternatives, such as maximum timber harvest (Alternatives D and E-Modified Departure), ecological restoration (Alternative C), and agency capacity, based on recent funding levels. Watershed objectives are best estimates of road treatment and restoration objectives and were set prior to any assessment of restoration or treatment need. Objectives are not meant to be targets or to set limits on the type or amount of restoration that may be completed over the life of the plan.

The objectives for treatment of hydrologically connected roads (in miles) and the percentage of hydrologically connected roads in priority watersheds to be treated in each alternative are displayed in Table 176. For example, in Alternative B the objective of treating 260 road miles is 23 percent of the approximately 1,128 miles of hydrologically connected roads estimated to occur in priority watersheds. Alternative D would potentially treat 58 percent of hydrologically connected roads in priority watersheds in 10 years. Based on the miles of existing roads, it would require a road treatment objective of 955 road miles (85 percent of connected roads) to reduce channel network extension by roads to less than 10 percent in all priority watersheds on the Malheur National Forest. Road treatment objectives are not displayed for Alternative A because similar numeric objectives were not established for the existing forest plan.

Table 176. Roads treatment objectives (miles) and percent of hydrologically connected roads that would be treated in priority watersheds for the plan revision alternatives for the Malheur National Forest

Roads Treatment Objective (first decade)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Roads that would be treated (miles)	260	600	650	290	310	500	310
Percent of roads in priority watersheds	23%	53%	58%	26%	27%	44%	27%

An estimated 35 percent of existing forest roads are hydrologically connected. The existing road system on the Malheur National Forest extends the channel network in priority watersheds, on average, by an estimated 55 percent, and as much as 97 percent, suggesting a relatively large influence on the rate of watershed runoff caused by forest roads (Wemple et al. 1996). While

there is no known published threshold value above which hydrologic connectivity leads to stream channel damage, this analysis assumes that channel network extension above 50 percent is likely to result in damage or degradation of stream channels, but allows that damage is possible when channel network extension due to roads is lower than 50 percent. Channel network extension of less than 10 percent is assumed to result in limited risk to watershed condition.

Hydrologic extension of the channel network in priority watersheds would be reduced from a present average of 55 percent to 23-42 percent depending on the alternative. Work would occur primarily in priority watersheds in which the present average hydrologic extension of 55 percent would be reduced to 23 and 26 percent, in alternatives D and C, respectively, 40 percent in Alternative E-Modified, and from 40 to 42 percent in all other alternatives (Table 177). The effect of treating hydrologically connected roads in priority watersheds is reflected in the difference in the percent network extension for all watersheds, compared to priority watersheds, after road treatment objectives are met. The extent of channel network extension due to the road system across all watersheds would be 46 percent or less for all action alternatives and would be a substantial improvement from existing conditions. However, channel network extension would remain near or above 40 percent in priority watersheds in Alternatives B, E, E-Modified, and F as displayed in Table 177.

Table 177. Average estimated channel network extension (percent) by alternative after road treatment objectives are met

Hydrologically Connected Roads Condition Class	Existing Condition	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All watersheds	50.0%	46.1%	40.8%	40.1%	45.6%	45.4%	42.4%	45.3%
PWS	54.7%	42.1%	25.6%	23.2%	40.6%	40.1%	30.4%	39.6%
KWS and PWS	55.0%	47.6%	38.1%	36.7%	46.8%	46.5%	40.9%	46.2%

PWS = priority watersheds; KWS = key watersheds

Combined model scores for roads are the average of scores for road density and hydrologically connected roads. Scores are based on existing National Forest System roads, which includes open and closed roads. For some, but not all closed roads, measures to reduce the hydrologic effects of roads are usually implemented at the time of closure. It is assumed that closed roads will generally have less effect on watershed function than open roads, but for the purposes of this analysis, differences in effect cannot be determined.

As above, roads scores for hydrologically connected roads in priority watersheds are reduced in proportion to the percentage of road treatment objectives to the sum of existing hydrologically connected roads (Table 178). Note that differences in model scores by alternative for all watersheds and key and priority watersheds combined are due only to the effect of meeting treatment objectives in priority watersheds. Resulting scores are highest in Alternatives D and C, and somewhat lower in all other alternatives. Treatment objectives for hydrologically connected roads range from 260 miles in Alternative B to 650 miles in Alternative D. For comparison, reducing road-stream connectivity to less than 10 percent in all priority watersheds would require the treatment of 925 road miles, or 275 miles more than would be treated in Alternative D.

Table 178. Existing and projected model scores for hydrologically connected roads by alternative, after roads objectives in priority watersheds are met

Average Score	Existing	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All Watersheds	-0.598	-0.446	-0.321	-0.293	-0.439	-0.436	-0.372	-0.433
PWS	-0.705	-0.403	0.124	0.244	-0.372	-0.360	-0.089	-0.348
KWS&PWS	-0.624	-0.424	-0.135	-0.069	-0.407	-0.400	-0.252	-0.394

PWS = priority watersheds; KWS = key watersheds

Table 179 displays the average model scores for hydrologically connected roads and road density combined. Lower scores in all alternatives relative to the values displayed in Table 178 reflect the effect of road density on watershed condition. Reducing hydrologically connected roads 925 miles in any alternative raise the scores in Table 178 to +1.0, but would only raise the scores in Table 179 to zero, indicating that roads would still have a moderate, although reduced effect, on watershed condition, suggesting a need to reduce road density further in order to improve watershed conditions.

In this analysis, road density and road-stream connectivity are weighted equally. If analysis assumptions regarding the effect of hydrologically connected roads are correct, then it would be logical to assume that the weight given to road density should be lower, which would result in proportionally higher combined roads scores in Table 179. At present, there is no known study on which to base a quantitative change in the effect of road density versus road-stream connectivity. However, there is mounting evidence in the literature that hydrologically connected roads are substantially more influential in altering streamflow and delivering sediment to streams (Bowling and Lettenmaier 2001, Bracken and Croke 2007, Mirus et al. 2007) and resulting effects to channel morphology (Pechenick et al. 2014).

Table 179. Combined roads scores (average of road density and hydrologically connected roads evaluation scores) – average scores for all watersheds, priority watershed, and key and priority watersheds

Average Score	Existing	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All Watersheds	-0.727	-0.651	-0.588	-0.574	-0.647	-0.646	-0.614	-0.645
PWS	-0.813	-0.662	-0.399	-0.339	-0.646	-0.641	-0.505	-0.635
KWS&PWS	-0.722	-0.622	-0.478	-0.445	-0.613	-0.610	-0.536	-0.607

PWS = priority watersheds; KWS = key watersheds

Key Indicator: Livestock Grazing

Eighty-one percent of the Malheur National Forest is suitable for grazing by cattle or sheep. Active allotments cover 91 percent of the national forest’s area. Acres suitable for domestic livestock would be essentially the same for Alternatives A, B, D, E, and F. Suitable acres would be 50 percent less for Alternative C. There would be 126,500 cattle and sheep animal unit months in Alternative B; 125,500 animal unit months for Alternative D; and 123,500 animal unit months in Alternatives A, E, and F. There would be 50 percent less animal unit months for Alternative C (62,200) and an estimated 133,000 animal unit months in Alternatives E-Modified and E-

Modified Departure. The change in animal unit months is used to recalculate relative forage use intensity by alternative and is assumed to change in all watersheds for the purpose of this analysis. Use intensity as defined by Holechek et al. (2006) is the ratio of forage consumed by livestock to annual forage production.

The difference in livestock numbers, in animal unit months, is used to calculate relative use intensity for the alternatives in each watershed within the national forest. Animal unit months were distributed to individual watersheds by summing suitable acres by allotment, then cross-walking allotment acres to subwatersheds using Geographic Information System (ArcMap) software. The calculation of forage use in this analysis assumes that all areas of an allotment could be used by domestic livestock, but that most use is limited to areas determined to be suitable for livestock use. Forage production in areas known to be unsuitable is given a nominal value of 50 pounds per acre per year so that most of the use is accounted for by acres that are suitable for domestic livestock.

The resulting average use intensity for all 143 subwatersheds and in priority watersheds only is displayed in Table 180. Calculated for existing conditions, 20 of 143 subwatersheds have apparent use intensity greater than 40 percent, the level proposed by Holechek et al. (2006) below which adverse effects to forage species are avoided. Average use levels are expected to be nearly the same for Alternatives A, B, D, E, and F, and slightly higher in Alternatives E-Modified and E-Modified Departure. Average forage use intensity would be lowest in Alternative C, due to the reduction in acres determined to be suitable for grazing. Use levels would be higher in E-Modified and E-Modified Departure (both 21.5 percent) because it assumed that livestock grazing would occur on currently vacant allotments, although grazing would not occur until the appropriate environmental analysis is completed for individual allotments.

The number of subwatersheds with the lowest relative use intensity would be nearly equal for Alternatives A, B, D, E, and F and somewhat higher in the two modified alternatives, because this analysis assumes that livestock use would be extended to currently vacant allotments. Livestock use would be lowest overall in Alternative C, particularly in priority watersheds, and similar in all other alternatives. This is true for all watersheds within the national forest, including priority watersheds.

Table 180. Average percent forage use intensity in all watersheds and in priority watersheds for each alternative for the Malheur National Forest

Watershed	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All Watersheds	23.5%	26.5%	14.2%	26.3%	26.0%	26.5%	26.5%	26.0%
Priority Watersheds	16.6%	20.9%	7.1%	20.7%	19.6%	22.9%	22.9%	19.6%
KWS & PWS	17.0%	20.5%	8.2%	20.3%	19.7%	21.4%	21.4%	19.7%

PWS = priority watersheds; KWS = key watersheds

Livestock use of riparian areas may be greater than use of uplands unless specific measures (herding, off-channel water sources, fencing, etc.) are implemented (Clary and Webster 1990, Fleischner 1994, Bengeyfield 2006). Livestock management in all plan revision alternatives would have the intent of improving or restoring riparian habitat conditions. Alternatives E-Modified and E-Modified Departure would include a guideline, GM-3G, which would require changes to livestock management in allotments where riparian desired conditions are not being

met, and which provides a mechanism for identifying the status of riparian habitats, clarifying the desired conditions, and adjusting livestock management so that progress or achievement of desired conditions can be attained (see Volume 4, Appendix A, text following Table A-32).

Key Indicator: Riparian Habitat Conservation Area and Riparian Management Area Acres

Present management of riparian areas under PACFISH (USDA and USDI 1995) and INFISH (USDA Forest Service 1995) includes the designation of riparian habitat conservation areas. Riparian habitat conservation areas are portions or zones of watersheds where riparian-dependent resources receive primary emphasis. The zones have varying widths: 300 feet on either side of fish-bearing streams and permanently flowing non-fish-bearing streams; 150 feet from ponds, lakes, reservoirs and wetlands larger than one acre; and 100 feet if listed fish are present from seasonally flowing streams, wetlands smaller than one acre, landslides, and landslide-prone areas (50 feet if listed fish are not present).

Riparian management areas for Alternatives B, E, F, E-Modified, and E-Modified departure would use the same basic definitions as riparian habitat conservation areas to define extent, with the exception that widths of 100 feet would apply to all seasonally flowing streams. Riparian management area widths would be 300 feet for all streams in Alternative C. In Alternative D, riparian management area widths would be 100 feet for fish-bearing streams, 70 feet for permanently flowing non-fish-bearing streams, and 50 feet for seasonally flowing streams, which will be higher than Oregon State Forest Practice Rules for some small streams. Complete definitions of Riparian Management Area widths and the conditions under which they are applied can be found in Appendix A, Volume 4.

Riparian management areas are designated as management areas where specific desired conditions, standards, and guidelines apply. Riparian goals in PACFISH and INFISH are restated as desired conditions for the plan revision alternatives. The management of riparian management areas and riparian habitat conservation areas would be similar in that work within riparian management areas would have to show progress towards desired conditions, and any management activity conducted within them would be designed specifically for the benefit of aquatic and riparian-dependent resources. Management of riparian habitat conservation areas currently requires that attainment of riparian management objectives not be retarded (USDA Forest Service 1995). Under all of the plan revision alternatives management actions would be designed and implemented with the intent of maintaining or achieving desired conditions, depending on whether desired conditions are currently being met.

The acres of riparian habitat conservation areas (Alternative A) and riparian management areas (all plan revision alternatives) and the minimum percent of national forest area are displayed in Table 181.

Table 181. Riparian management area (RMA) acres and percent of Malheur National Forest for each alternative (riparian habitat conservation areas or RHCAs for Alternative A)

Alt. A RHCAs acres (%)	Alt. B RMAs acres (%)	Alt. C RMAs acres (%)	Alt. D RMAs acres (%)	Alts. E RMAs acres (%)	Alts. E Mod. RMAs acres (%)	Alts. E Mod. Dep. RMAs acres (%)	Alt. F RMAs acres (%)
168,545 (10%)	192,910 (11%)	368,998 (22%)	83,078 (5%)	192,910 (11%)	192,910 (11%)	192,910 (11%)	192,910 (11%)

The default widths of riparian management areas would be highest in Alternative C. For Alternative C, which would have 300-foot-wide buffers for all streams, regardless of class. Alternative D would have the least acres within riparian management areas because widths would be the narrowest for streams in all classes. Oregon Forest Practices guidelines, on which the riparian management area widths in Alternative D are based, do not require riparian management areas for the smallest non-fish-bearing streams with average annual flow of less than 2 cubic feet per second. A review by the Independent Multidisciplinary Science Team (IMST 1999) of the riparian management areas required by the Oregon Forest Practices Act found that riparian management areas required by the act were insufficient to protect aquatic habitats because they were not applied to all streams and specifically not to non-fish-bearing streams. However, Alternative D, as currently designed, would apply riparian management areas to intermittent and seasonally flowing streams that exceed the requirements of the Oregon Forest Practices Act.

Some reviews of the effectiveness of protective zones for riparian areas have concluded that widths of 300 feet, or one site-potential tree, are required in order to protect all of the desired functions of riparian areas (Wenger 1999). A review by Castelle and Johnson (2000) suggests that riparian buffer widths of 5 to 15 meters (16 to 49 feet) are sufficient to provide 50 to 75 percent of desired riparian functions, which include sediment filtration, stream temperature moderation, inputs of large organic debris, production of fine particulate organic matter, and stream bank stability. Castelle and Johnson (2000) found that the effect of vegetation on bank stability is primarily provided through fine roots within stream banks. A study by Lakel et al. (2010) conducted in the Virginia Piedmont indicated that undisturbed riparian strips 50 feet wide were capable of trapping 97 percent of eroded sediment as long as flow was not channelized. Tang and Montgomery (1995) suggest that riparian buffers 100 meters wide would include 75 to 90 percent of potentially unstable ground in watersheds within the Olympic Peninsula in Washington. This finding is important because the Olympic Peninsula includes some of the steepest and most erodible terrain on the U.S. west coast. A review by Pollock and Kennard (1998) concluded that buffer widths of 50 to 250 feet should be sufficient to provide most, if not all, of the desired functions of riparian areas in watersheds in eastern Washington. Lastly, much of the original rationale used to define the zones that would protect the various functions of riparian zones for the Northwest Forest Plan, and then PACFISH, comes from FEMAT (1993). The FEMAT report provided an assessment of various riparian processes as a function of distance from the stream edge for areas west of the Cascade Crest in Oregon and Washington. These processes include root strength and its contribution to bank stability, the recruitment of large wood to stream and riparian areas, the input of leaf and particulate organic material, microclimate, air temperature, soil temperature, provision of shade from incoming solar radiation, and wind speed (Figure 33 and Figure 34).

Figure 33 and Figure 34 display that the contribution of root strength to bank stability in forested riparian areas occurs within about 0.25 tree heights from the stream edge. If potential tree height is 100 feet, then most of the contribution of vegetation to bank stability occurs within 25 to 30 feet of stream edge. The contribution of litter fall, large wood and shade decreases with distance from streams, but nearly all of the benefit occurs within the first 100 feet.

Along low gradient, meandering streams in wide, unconfined valleys, the dominant contribution to bank stability is from deep-rooted herbaceous species (Dunaway et al. 1994) that have rooting depths that may exceed 3 feet (Manning et al. 1989). In wet meadows bordering some streams, herbaceous vegetation on streambanks, provides a dense root mass that may be highest in the first few feet from very small streams, as these species are the most tolerant of inundation, and have rooting characteristics that allow them to thrive in saturated soil conditions. Rosgen (1994) E

channels are small low-gradient streams in which bank stability is provided by the roots of herbaceous riparian species. Riparian shrub species are also deep-rooted, but have differing inundation tolerances and water requirements that affect their distribution. Willow species may occur at the stream edge, but may also span the entire width of floodplains. In small streams, willows (and dogwood, alder, or birch), and in some case herbaceous species are the primary contributors of stream shade.

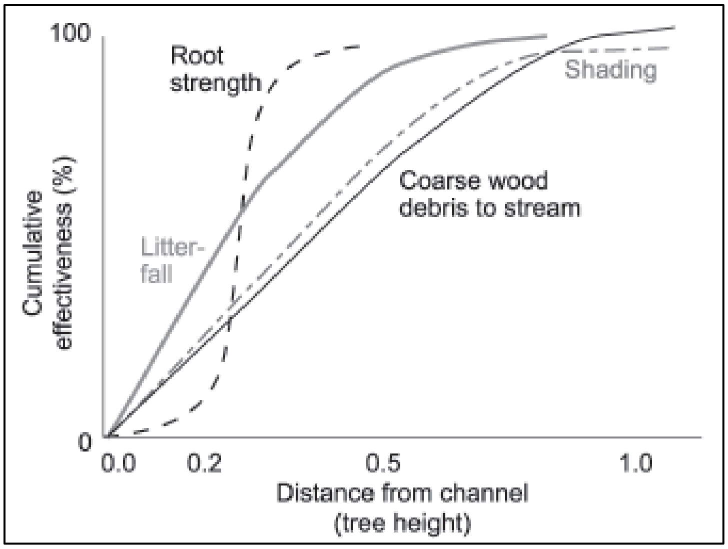

Figure 33. Generalized curves indicating percentage of riparian ecological functions and processes occurring within varying distances from the edge of a forest stand (from Everest and Reeves (2007) and FEMAT (1993)

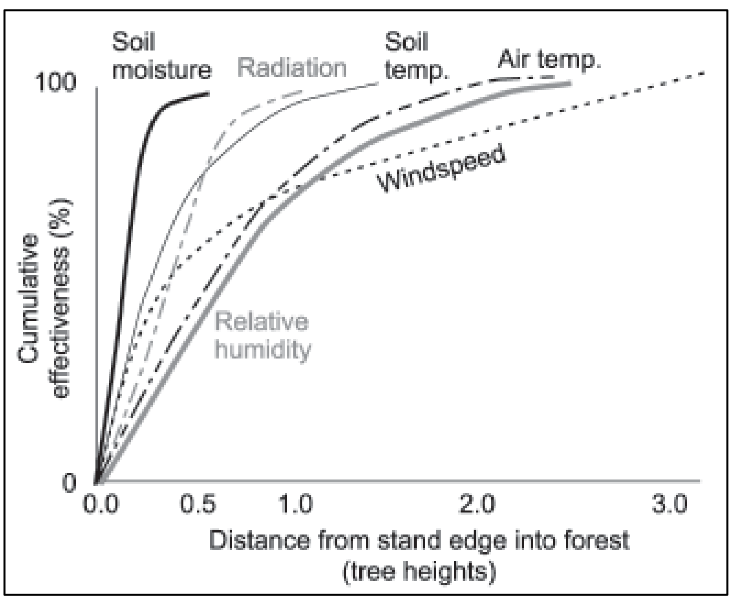

Figure 34. Generalized curves indicating percentage of microclimate attributes occurring within varying distances of the edge of a riparian forest stand (Chen 1991) (from FEMAT 1993, Everest and Reeves 2007)

Soil moisture in forested riparian areas is highest within ½ tree height, but could be much greater in low-gradient streams in very wide valleys. The benefits of riparian vegetation in moderating, incoming solar radiation, relative humidity, soil temperature, and air temperature may extent to more than 200 feet from the stream edge. This effect may be very different in north-facing versus south or west-facing watersheds.

A review of riparian reserve widths by Everest and Reeves (2007) concluded that there was no scientific evidence that the default prescriptions provided more protection than necessary to meet the stated riparian management goals of the Northwest Forest Plan. More recently, Reeves et al. (2013) concluded that most wood recruitment to streams occurs from within a zone roughly 100 feet from the stream edge, emphasizing that protection of this zone is possible while still managing the area outside of this zone for other riparian attributes.

Based on available reviews of the effectiveness of protective buffers for riparian areas, the Riparian Habitat Conservation Areas of Alternative A , and the riparian management areas proposed for Alternatives B, E, F, E-Modified and E-Modified Departure and, should be protective of riparian functions and would apply to the entire channel network. Riparian management areas will be delineated during project level planning and include areas of potentially unstable ground. The effect of including landslide-prone and unstable hillslopes in riparian management areas should provide benefits similar to the wider riparian management areas in Alternative C.

The riparian management areas proposed for Alternative C would likely be the most protective of unstable areas, as described by Tang and Montgomery (1995), but riparian management areas in all other plan revision alternatives except D could be nearly as protective if applied correctly. Those proposed for Alternative D would be the least protective and may not be as effective as the riparian management areas in all other alternatives at preventing sediment delivery to streams or providing for inputs of large organic debris. In particular, riparian management area widths in Alternative D are likely to be less protective of seasonally flowing streams and headwater streams that are the sources of large wood for higher order streams (Benda et al. 2003, 2005). In addition, current knowledge of transport distance of concentrated runoff from roads make it unlikely that sediment delivery from roads to streams could be effectively reduced with the narrower riparian management area widths of Alternative D.

Key Indicator: Number of Wetland Sites Improved

Wetlands in National Forest System lands occur in a variety of settings, not all of which are associated with streams or rivers. Based on maps compiled by the U.S. Fish and Wildlife Service and provided to the National Wetlands Inventory, off-channel and isolated wetlands comprise an area that is 40 percent or more of all wetlands within the Malheur National Forest. According to these maps, there potentially are more than 2,000 small wetlands within the Malheur National Forest, although the accuracy of the maps is not yet determined. These wetlands are an important component of the hydrology of watersheds within the national forest but are disproportionately important, relative to their size, as habitat for a variety of plant and animal species, and, in some cases, include species that occur only in specific wetland types. The objective for improvements to or restoration of a small number of these sites each year is included in each alternative and displayed in Table 182. Potential actions include vegetative restoration, hydrologic restoration, and protection by fencing and conversion to use by wildlife.

Table 182. Objective for wetland site restoration for the plan revision alternatives for the Malheur National Forest. Objectives are not shown for Alternative A because they were not part of the original (1990) forest plans.

Wetland Site Restoration Objective (first decade)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Number of sites	20	30	30	30	30	30	30

Key Indicator: Riparian and Stream Channel Restoration

Within priority watersheds in the Malheur National Forest, there are approximately 554 miles of perennial streams or an average of 16.3 miles in each of 26 subwatersheds. Using a nominal habitat width of 25 feet, riparian habitats encompass an estimated 1,680 acres. The objectives for passive and active stream channel and riparian restoration for the action alternatives are summarized in Table 183. The sums of stream and riparian miles and riparian habitat acres are displayed in the table along with the percentage of habitats that would be improved based on objectives for each alternative.

Table 183 displays the channel and riparian habitat objectives for the first 10 years following implementation the revised forest plan on the Malheur National Forest. The objectives total 64 to 128 stream miles, depending on the alternative, and represent 12 percent to 23 percent of stream miles in priority watersheds. This should be sufficient to effectively restore the main-stem channel in multiple subwatersheds. Similarly, the sum of objectives for riparian and wetland restoration range from 427 to 941 acres, representing an estimated 25 percent to 56 percent of riparian and wetland acres in priority watersheds. This analysis recognizes that some objectives overlap in that more than one objective may apply to the same stream reach. As a result, the effect of implementing restoration objectives is treated conservatively in this analysis. In addition, habitat restoration will likely focus on main-stem reaches with riparian zones wider than 25 feet, but some restoration work could occur on smaller streams in which riparian vegetation may be limited to a narrow fringe that could be only a few feet wide. Note that based on riparian restoration accomplishment, Alternatives C and D have similar outcomes, although the types of restoration actions could be quite different between these two alternatives. The largest improvement in riparian and stream channel condition in this analysis would occur in the alternative that treats or improves the largest number of acres of riparian habitat. Among the action alternatives, the lowest outcome would occur in Alternative B and the highest in Alternative C. Alternative E-Modified would result in the highest outcome in stream miles improved and third highest outcome in riparian areas improved, based on the objectives displayed in Table 183 and the Forest Plan. Restoration objectives are not displayed for Alternative A because they were not established in the original (1990) Forest Plans. Stream, riparian, wetland, and aquatic habitat restoration has occurred, and continues to occur under the existing plans based on priorities established by each National Forest in 2005 and updated through the Watershed Condition Framework in 2011.

Table 183. Passive and active riparian, stream channel and aquatic habitat restoration objectives for the Malheur National Forest (expected annual accomplishments). Objectives are not displayed for Alternative A, because they were not established for the original Forest Plans.

Objective Statements for the Malheur National Forest	Units	Alt B	Alt C	Alt D	Alt E	Alt E-Mod.	Alt E-Mod. Dep	Alt F
Restore & enhance floodplain connectivity	miles	5.5	6.0	5.0	8.0	8.0	8.0	7.5
Restoring riparian & wetland species composition - passive restoration	acres	20.0	30	20	30	30	30	27.5
Increasing effective stream shade & riparian shrubs	miles	30.0	60	30	45	45	42	40
Enhancing off-channel & isolated wetlands*	acres	2.0	3	3	3	3	3	3
Increasing the number & extent of beaver created wetlands	acres	5.0	7.5	5	6	6	6	5
Improving riparian habitat conditions (active & passive restoration)	acres	400	900	900	600	600	550	570
Restoring channel morphology	miles	25	40	25	38	38	34	35
In-channel stream habitat improvement	miles	5.0	1.7	5	7.5	8	7	7
Replacing culverts to provide passage to upstream habitat	miles	6.0	10	6	9	9	9	8
Implementing water quality restoration plans	miles	24.0	32	18	20	20	20	17
Sum of stream miles	NA	71	110	64	90	128	120	80
Percent of stream miles improved	NA	13%	20%	12%	16%	23%	22%	14%
Rank of alternative	NA	6	3	7	4	1	2	5
Sum of riparian and wetland acres improved	NA	427	941	928	639	639	589	606
Percent of habitat acres improved	NA	25%	56%	55%	38%	38%	35%	36%
Rank of Alternative	NA	7	1	2	3	3	6	5

* Isolated wetlands treated as 1 acre per site. Beaver created wetlands treated as 5 acres per site. Water Quality Restoration Plan miles are the average of range from Appendix A. Stream miles are converted to habitat acres using a channel width of 25 feet. Assuming most work will be on small streams; this is equivalent to 3.03 acres per stream mile. For comparison of alternatives, highest total is ranked 1; lowest total is ranked 7.

NA = not applicable

Channel condition in this analysis is based on a combination of physical (channel) and riparian attributes (Figure 26). This implies that achieving desired aquatic habitat conditions requires both favorable channel attributes and desired riparian attributes. Based on the percentage of stream miles and riparian acres improved or restored, the change in existing channel condition scores is recalculated by adding 0.2 times the percentage of stream miles improved plus 0.4 times the percentage of riparian acres improved to existing numerical condition scores for each priority watershed. Riparian attributes are weighted higher here because of the influence that riparian vegetation has in maintaining stream channel functions (Naiman et al. 1992). The resulting

average difference in channel condition scores from existing conditions are displayed by alternative in Table 184.

Table 184. Computed change in channel condition scores resulting from achieving stream channel and riparian habitat restoration objectives on the Malheur National Forest

Average Score	Existing	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All Watersheds	-0.071	+0.036	+0.068	+0.064	+0.049	+0.053	+0.049	+0.047
PWS	-0.074	+0.053	+0.190	+0.170	+0.111	+0.125	+0.110	+0.099
KWS&PWS	-0.081	+0.034	+0.109	+0.098	+0.065	+0.073	+0.065	+0.059

PWS = priority watersheds; KWS = key watersheds

The effect of achieving restoration objectives, as displayed in Table 184, is to change average channel condition scores on the Malheur National Forest from small negative values to small positive values, on average. The largest numeric difference, and largest improvement in condition, would occur in priority watersheds because they are the intended focus of riparian and aquatic habitat-related restoration. There may be a stronger long-term benefit in watersheds where restoration restores connectivity between stream channels and floodplains, improves recruitment and establishment of riparian species, and/or results in stable channel configurations, all of which contribute to achieving desired conditions. Based on the objectives assigned to each alternative, the largest improvement in channel condition would occur in Alternative C, and the smallest improvement in Alternative B. Alternative E-Modified would result in the third-highest improvement in channel and riparian habitat conditions. All of the action alternatives would result in improved channel and riparian conditions. Based on ongoing restoration work, channel and riparian conditions should also improve in Alternative A, and some or all of recent restoration work has occurred in watersheds named as priorities for restoration in the action alternatives. The overall numeric outcome would be similar to, but slightly lower than the values displayed for Alternative B in Table 179.

Stream channel restoration is expected to include a variety of activities in addition to, or in place of, physical channel reconstruction. Other actions could include placement of large wood, reconnection of side channels, or conversion of water rights to restore or protect instream flows, and reintroduction of beaver to suitable sites. Replacement or removal of culverts that block access to potential habitat is ongoing and expected to continue at varying rates, depending on the alternative selected. Redesign of road-stream crossings is also likely to contribute to improved channel and habitat conditions, both upstream and downstream of these sites. The stream miles displayed in Table 183 are much lower than total stream miles in priority watersheds, but it is likely that only a small percentage of stream channels are in actual need of this kind of restoration. Improvements to stream channel conditions would also occur in response to expected improvements in upland and riparian conditions but full recovery may require longer timeframes. Active channel restoration could occur in 13 to 23 percent of stream miles in priority watersheds, depending in the alternative selected. The objectives for stream restoration are lowest for Alternatives B and D, and highest for Alternatives C, E-Modified Departure, and E-Modified. Based on objectives, more stream miles would be restored under Alternative E-Modified than in any other alternative, including Alternative C. Alternative B was designed to have higher stream, riparian, and aquatic habitat restoration objectives than is currently being accomplished under the existing forest plans (Alternative A).

Key Indicator: Watershed Condition Class—Number of Watersheds in Improved Condition

The combined effects of improvement in upland and riparian vegetation, treatment of hydrologically connected roads, differences in livestock use and changes in channel and riparian habitat conditions are used to compute condition scores for each alternative (Figure 26, Table 185 and Table 186). Changes in the departure of upland and riparian vegetation over time are based on modeled rates of forest growth, assumptions of the frequency and magnitude of disturbance, and estimates of the rates of timber harvest among management areas. Livestock use is based on comparison of forage use to average forage production. The effects of roads are addressed by the combination of road density and the miles of hydrologically connected roads with the goal of reducing connectivity between roads and streams. Changes in channel and riparian conditions from existing conditions are based on achieving the riparian and stream channel objectives in Appendix A, Volume 4 as listed in Table 183.

In combination, these differences reflect the relative influence of differences in management and restoration actions between the alternatives. Watershed conditions on the Malheur National Forest are strongly influenced by high existing road densities. The treatment of hydrologically connected roads would occur in priority watersheds first, then other watersheds as funding permits. The benefit of reducing road-stream connectivity is supported by model results, but improvements in overall condition are smaller, because road density remains high. Changes in vegetation condition are solely responsible for the increase in the number of watersheds improved from year 10 to year 20.

For reasons stated at the beginning of this analysis, road density is assumed not to change. The evaluation of the effects of specific roads on watershed, riparian, stream channels, water quality, and aquatic habitats, and for which the only practical means of reducing or eliminating the effect is to decommission the road, is necessarily outside the scope of this analysis. The identification of roads within 300 feet of streams is a starting point for locating the roads most responsible for sediment delivery to streams, degradation of aquatic and riparian habitats, and water quality. Identification of the treatment needs of these roads is also likely to identify the roads or road segments from which reducing sediment delivery to streams is not possible and are candidates for decommissioning.

Improvements to upland conditions will eventually contribute to improved conditions in riparian and aquatic habitats by moderating watershed hydrology, reducing the rate of watershed runoff, and reducing sediment delivery to streams. Channel response to these changes could take years to decades, and depends to some extent on the frequency and magnitude of future disturbance, but is strongly dependent on the recovery of riparian vegetation.

Table 185 and Table 186 display averages of combined watershed condition scores for the existing condition, year 10 and year 20 and include updated channel condition scores based on implementation of all stream channel and riparian habitat restoration objectives.

All of the scores are intermediate or neutral values given that the possible range varies between +1 and -1. Low existing scores are influenced by high road density, moderately high departure of forest and riparian vegetation, and relatively low aquatic habitat condition. Model scores are all affected by the relatively high road density that outweighs the effect of greatly reduced livestock use in Alternative C. At year 10, Alternative C produces the best average outcome for all watersheds, priority watersheds, and key and priority watersheds combined. Alternative D results in the second highest outcome for priority watersheds that is mainly the result of a higher

expectation of treating hydrologically connected roads than the remaining alternatives. High road density has a negative effect on the condition outcomes of all alternatives.

Table 185. Average of combined watershed condition evaluation scores for existing condition and year 10 by alternative (high positive scores reflect better average condition; low negative scores reflect poorer average condition)

Category	Existing	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All watersheds	-0.265	-0.198	-0.226	-0.046	-0.185	-0.205	-0.190	-0.210	-0.212
PWS	-0.195	-0.104	-0.151	0.116	-0.056	-0.096	-0.126	-0.141	-0.114
KWS & PWS	-0.184	-0.106	-0.145	0.072	-0.082	-0.113	-0.114	-0.132	-0.122

PWS = priority watersheds; KWS = key watersheds

Table 186. Average of combined watershed evaluation scores at year 20 by alternative

Category	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All watersheds	-0.182	-0.210	-0.015	-0.165	-0.180	-0.153	-0.182	-0.192
PWS	-0.067	-0.122	0.157	-0.032	-0.059	-0.083	-0.106	-0.082
KWS & PWS	-0.075	-0.115	0.114	-0.052	-0.076	-0.067	-0.093	-0.089

PWS = priority watersheds; KWS = key watersheds

Differences among the alternatives are more apparent when watersheds are summed by condition classes (Table 187 and Table 188). Based on reductions in miles of hydrologically connected roads, improvements in vegetation conditions, and differences in livestock use between alternatives, at year 10 Alternative C results in the biggest improvement over existing conditions. Alternatives E-Modified and E-Modified Departure result in the second greatest improvement in watershed conditions, although as seen in the model scores, differences in condition are relatively modest. The differences between Alternative C and the modified alternatives is of interest because livestock use decreases in Alternative C and increases in both modified alternatives. Road treatment objectives are also higher in Alternative C than in the modified alternatives. The remaining difference is that forest vegetation condition improves slightly faster in the modified alternatives than in Alternative C.

Table 187. Combined watershed condition, by condition class at year 10 and subwatersheds in each class along with subwatersheds improved at year 10 for each alternative for the Malheur National Forest (existing condition numbers are in parentheses)

Watershed Condition Class (all watersheds)	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep. Yr. 10	Alt. F Yr. 10
1 (0)	1	1	6	2	0	2	1	1
2 (81)	106	99	114	106	103	109	107	99
3 (62)	36	43	23	35	40	32	35	43
Subwatersheds improved	26	19	39	27	21	30	26	19

Table 188. Watershed condition classes and priority watersheds in each class along with priority watersheds improved at year 10 for each alternative for the Malheur National Forest

Watershed Condition Class	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep. Yr. 10	Alt. F Yr. 10
1 (0)	1	0	3	1	0	0	0	0
2 (29)	30	30	31	33	32	33	34	30
3 (5)	3	4	0	0	2	1	0	4
Priority watersheds improved	2	1	5	5	2	4	4	1

Table 189 and Table 190 show condition classes at year 20. Differences in condition between year 10 and year 20 in these tables are due to changes in forest and riparian vegetation condition and continued improvement in riparian and channel conditions that are expected to result from implementation of restoration actions through the first 10 years of plan implementation. The differences remain small, but there is an incremental increase in the number of watersheds in condition class 1 (Alternatives C and D) as well as an incremental increase in the number of watersheds improved (Alternatives C, D, E-Modified Departure, and E-Modified).

Table 189. Watershed condition classes and subwatersheds in each class along with subwatersheds improved at year 20 for each alternative for the Malheur National Forest (all watersheds)

Watershed Condition Class	Alt. A Yr. 20	Alt. B Yr. 20	Alt. C Yr. 20	Alt. D Yr. 20	Alt. E Yr. 20	Alt. E-Mod. Yr. 20	Alt. E-Mod. Dep. Yr. 20	Alt. F Yr. 20
1 (0)	3	4	19	7	5	4	4	5
2 (81)	103	97	101	102	102	112	105	98
3 (62)	37	42	23	34	36	27	34	40
Subwatersheds improved	25	19	39	27	25	35	28	22

Table 190. Watershed condition classes and priority watersheds in each class along with priority watersheds improved at year 20 for each alternative for the Malheur National Forest

Watershed Condition Class	Alt. A Yr. 20	Alt. B Yr. 20	Alt. C Yr. 20	Alt. D Yr. 20	Alt. E Yr. 20	Alt. E-Mod. Yr. 20	Alt. E-Mod. Dep. Yr. 20	Alt. F Yr. 20
1 (0)	1	1	10	3	2	0	0	1
2 (29)	31	30	24	31	30	33	33	30
3 (5)	2	3	0	0	2	1	1	3
Priority watersheds improved	3	1	5	4	2	4	4	2

This analysis has not explicitly incorporated impacts to soils, although roads, livestock grazing, and timber harvest all have varying impacts to soils that can and have resulted in loss of soil productivity. The wide range in estimates of detrimental soil conditions, as described in the soils section of this document make the use and application to watershed conditions highly uncertain.

Another source of uncertainty is in the rate at which soil recovery occurs, for example from soil compaction. Logging and grazing have occurred in parts of the Blue Mountains for nearly 150 years. Mechanized logging began by about 1920, increased rapidly after about 1950, then declined after the mid-1990s. Some recovery of soils compacted during logging likely has occurred on all sites, but the recovery rate varies with the severity of the original disturbance, soil characteristics, and local climate. This analysis recognizes that some recovery of compacted soils may occur within a few years after disturbance, but the required for full recovery from severe soil compaction on some sites likely exceeds 200 years (Knapp 1989, 1991).

The estimate of existing area of detrimentally disturbed soils on the Malheur National Forest range from around 52,000 acres (3 percent of the forest) to about 250,000 acres (15 percent of the forest). Some of the effect of over-estimating existing road miles and hydrologically connected roads in this analysis offsets some of the effects of historic disturbance to soils.

Table 191 summarizes the estimates of detrimental soil conditions expected to result from each of the alternatives annually and the sum of soil improvement objectives for each alternative. The difference between the estimates of soil disturbance and soil improvement represents the net effect of each alternative on soil conditions without accounting for implementation best management practices or project-specific mitigation measures intended to reduce impacts to forest soils. Alternatives with the highest levels of mechanical vegetation management are expected to have the highest amounts of detrimentally disturbed soils.

Table 191. Potential acres of detrimental soil conditions and acres improved (treated) annually each alternative for the Malheur National Forest and NET acres improved (treated minus DSC acres)

Soil Condition	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Area disturbed (DSC)	737	818	415	2,738	1,399	1,310	1,976	947
Area improved (treated)	no data	750	1,250	600	900	575	805	900
Net	no data	-68	+835	-2,138	-499	-735	-1,171	-47
10-year total	no data	-680	+8,350	-21,380	-4,990	-7,350	-11,710	-470

DSC = detrimental soil conditions

Alternative C has the largest net improvement in soil conditions. Alternatives F and B would have relatively small annual net reductions in soil conditions. Alternative D would have the largest net loss in soil conditions and is expected to have the highest levels of mechanical disturbance to soils. As described earlier in this section, effects to soils are partially offset by overestimating the effects of roads when calculating model scores for watershed conditions. This overestimate results from including decommissioned and closed roads in the assessment of watershed condition, in lieu of separately summing detrimental soil conditions. The soils section of this document displays estimates of detrimental soil conditions from historic logging that vary over a wide range, based on currently available information.

The results of the analysis of watershed conditions on the Malheur National Forest are tempered by the projection that the potential net area of detrimental soil conditions during the first decade of the plan period could increase by 400 to more than 2,100 acres per year in five of seven action

alternatives. Alternatives B and F would result in small net losses of soil productivity. Alternative C is the only alternative that would result in a net improvement in soil conditions because the acres proposed for soil improvement are greater than the acres of expected disturbance. Detrimental soil disturbance in Alternative D over a 10-year period would be nearly 30,000 acres higher than in Alternative C based on the expected level and type of management actions that would occur in each alternative. Net reductions in soil conditions would occur in all of the other action alternatives with the largest reductions occurring in Alternatives D and E-Modified Departure. The potential for additional detrimental impacts to soils could be reduced or minimized by adherence to soil quality standards, application of best management practices, and the design of future projects, in which impacts could be limited to previously disturbed soils.

Soil compaction and loss of ground cover influence hydrologic conditions in watersheds and increase the potential for surface soil erosion. Sites of detrimental soil disturbance represent an increased risk of sediment delivery to streams when the sites occur near streams or near hydrologically connected roads. Objectives for improving soil hydrologic function in areas disturbed by management activities would be less than the acres of new disturbance for all alternatives except Alternative C.

In addition, the influence of disturbed soils on hydrologic processes depends on the location and connectivity of disturbed soils in relation to existing roads and the layout of past harvest units in relation to streams. Following Lee et al. (1997) this analysis assumes that roads are related to other watershed effects, including effects to soils by timber harvest. This analysis may overestimate the effect of roads on watershed conditions because of the inclusion of closed and decommissioned roads. Decommissioned roads were included in the analysis because the method of decommissioning and condition of individual roads was unknown. Recent studies (Black et al. 2017) have shown that regardless of the method, decommissioning of forest roads on the national forests in the Pacific Northwest has been effective at reducing erosion and subsequent sediment delivery to streams.

Summary of Effects of the Alternatives to Watershed Condition on the Malheur National Forest

- Alternative E-Modified would result in the greatest improvement in upland and riparian forest vegetation, followed by Alternative D for upland vegetation and Alternative E-Modified Departure for riparian vegetation
- Alternatives D and C result in the greatest reductions in road-stream connectivity (all in priority watersheds)
- Livestock use intensity in uplands and riparian areas is lowest in Alternative C because of the reduced extent of acres suitable for livestock grazing. Alternatives E-Modified and E-Modified Departure have the highest expected livestock use because of the expectation of allowing grazing in currently vacant allotments.
- Stream channel and riparian habitats would be most improved in Alternatives C, D, and E-Modified.
- At year 10, average watershed conditions would be most improved in Alternatives, C, D, and E-Modified. Watershed condition in priority watersheds would be most improved in Alternatives, C, D and E-Modified. Conditions in priority watersheds would be most improved in Alternatives C, D and E; Alternative E-Modified would rank 6th. The ranking

of Alternative E-Modified is influenced by high existing road densities in priority watersheds and higher livestock use intensity.

- At year 20, the greatest improvement in watershed conditions would occur in Alternatives C, E-Modified, and D. The greatest improvement in priority watersheds would occur in Alternatives C, D, and E, with Alternative E-Modified ranking 6th because of higher road density and higher livestock use intensity.
- Using the sum of watersheds that change condition class by year 20 (from class 3 to class 2 and class 2 to class 1, as described earlier in this section), as "watersheds improved," Alternative C would result in the most watersheds improved (39), followed by Alternative E-Modified (35), and Alternatives D and E-Modified Departure (28). The number of priority watersheds improved would be highest in Alternatives C and D (5 each), and Alternatives E-Modified and E-Modified Departure (4 each).
- Alternative C would have the most watersheds in functional condition (class 1) after 20 years (19, including 10 priority watersheds). Alternative C has the highest objectives for riparian and stream channel restoration, the lowest expected livestock use – although the difference livestock use is limited to specific watersheds, and relatively large reductions in road-stream connectivity. In comparison, Alternative D would result in seven watersheds in functional condition and Alternatives E-Modified and E-Modified Departure would each have four.
- The acres of detrimental soil conditions combined with expected riparian and aquatic habitat restoration activities support that Alternative C would result in the greatest improvement in watershed conditions while the least overall improvement in watershed conditions would occur for Alternative D.

Umatilla National Forest

The indicators used to display differences in the effects of the alternatives are described in the same order they were for the Malheur National Forest. Some of the explanatory text and rationale for the use of individual indicators in the description of effects on the Malheur National Forest is not repeated in this text because the rationale and assumptions of the analysis are the same for all three forests. A summary and comparison of the factors that influence condition outcomes for each forest follows the effects analysis for the Wallowa-Whitman National Forest.

Effects of the alternatives are described in the following order:

1. Upslope conditions within watersheds are described by expected changes in the condition of forested vegetation, hydrological connectivity of the road system, and livestock use intensity
2. Differences between alternatives in the effects of grazing on riparian habitats
3. Differences in the extent of riparian management areas
4. The influence of differences in riparian habitat conservation areas and riparian management areas
5. The effect of proposed riparian, wetland and stream channel restoration
6. The extent of detrimental soil conditions resulting from expected levels of timber harvest
7. Changes in overall watershed conditions, considering all of the above factors

As in the analysis for the Malheur National Forest, the expected change in the condition of vegetation attributes, riparian and stream channel attributes, and overall watershed conditions are displayed for years 10 and 20 following implementation of the forest plan.

Key Indicator: Vegetation Condition

The percent area and average departure of each potential vegetation group within the Umatilla National Forest are displayed in Table 192. Dry forest occurs on 42 percent of the Umatilla National Forest and is the most departed from the historical range of variability of the three forested vegetation classes based on comparison to the historical range of stand density, age class structure, and species composition. The three main forest potential vegetation groups encompass about 81 percent of the National Forest.

Table 192. Percent of national forest and average departure score by potential vegetation group for the Umatilla National Forest

Potential Vegetation Group	Percent of Umatilla	Average Departure Score
Dry forest	42%	60
Moist forest	31%	23
Cold forest	8%	13

From an analysis of vegetation data aggregated for all potential vegetation groups for the Umatilla National Forest, all 129 subwatersheds assessed have vegetation that is moderately departed from the historical range of variability, meaning that departure scores for individual watersheds are between 33 and 66 (on a scale of 0 to 100).

Table 193 displays the average existing departure scores for all watersheds, priority watersheds, and key and priority watersheds combined and expected departure scores by alternative at year 10.

Table 193. Average of subwatershed forest vegetation departure in all watersheds, priority watersheds, and in key and priority watersheds combined at year 10 for each alternative for the Umatilla National Forest

Forested Vegetation Departure	Existing Condition	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep Yr. 10	Alt. F Yr. 10
All WS (129)	52.5	45.2	46.7	43.6	39.3	46.4	45.5	45.6	46.5
PWS (15)	55.1	47.8	49.3	47.3	43.5	48.6	47.9	48.0	48.8
KWS and PWS (52)	49.9	42.2	44.1	39.9	36.5	44.1	42.9	43.0	44.0

PWS = priority watersheds; KWS = key watersheds

On the Umatilla National Forest, the lowest departure scores, and most improved vegetation condition at year 10 occur in Alternative D (39.3), then C (43.6), then Alternatives E-Modified (45.5) and E-Modified Departure (45.6), among the plan revision alternatives. The values presented in Table 193 area averages across all watersheds, and do not vary greatly between alternatives except that Alternative D is the only alternative that results in average departure value under 40. In 10 years, Alternative D could result in 48 of 129 subwatersheds with vegetation in least departed condition (less than 33), and Alternative C could result in 32 subwatersheds in with

forest vegetation in least departed condition. No other alternative would result in forest vegetation in more than 3 watersheds in least departed condition. Departure values for individual watersheds vary from 23 percent to 62 (compared to 36 to 66 existing) percent and the range of values varies by alternative.

By year 20, average departure scores at the forest scale remain moderately departed, but decline by 2 to 10 percent from year 10 values, and by as much as 18 percent from the existing condition. Departure values for individual watersheds range from 15 to 58 percent for individual watersheds and the range varies by alternative. Across all watersheds, the lowest average departure of forest vegetation would occur Alternative D. The lowest forest vegetation departure in priority watersheds and key watersheds would occur in Alternative F. Departure values in Alternative E-Modified would be slightly higher than in Alternative F after 20 years.

Table 194. Average of forest vegetation departure scores at year 20 for all watersheds, priority watersheds, and key and priority watersheds combined

Forested Vegetation Departure	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep Yr. 10	Alt. F Yr. 10
All WS (129)	42.8	42.5	41.4	37.7	42.0	40.5	42.6	40.1
PWS (15)	45.7	45.2	45.3	41.6	44.0	42.9	44.7	37.5
KWS and PWS (52)	39.3	39.7	37.7	36.1	39.7	37.7	39.4	35.4

PWS = priority watersheds; KWS = key watersheds

Riparian Vegetation Departure - Riparian vegetation departure in this analysis is calculated for forest vegetation within riparian management areas. Departure values for forest vegetation in riparian zones at year 10 and year 20 are displayed in Table 195 and Table 196. At year 10, lowest average vegetation departure scores would occur in Alternatives C and D, then Alternative E-Modified, and all other alternatives except A would have slightly higher, but similar departure scores. The least improvement in forest vegetation in riparian zones is expected to occur in Alternative B.

Table 195. Riparian vegetation departure scores at year 10, Umatilla National Forest

Forested Vegetation Condition Class	Existing Condition	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep. Yr. 10	Alt. F Yr. 10
All watersheds	52.3	44.2	46.4	41.2	42.1	46.1	44.2	44.2	46.0
PWS	54.3	46.2	48.4	44.8	45.3	47.9	45.7	45.7	47.9
KWS and PWS	50.7	42.5	44.7	38.1	39.1	44.9	42.7	42.7	44.6

PWS = priority watersheds; KWS = key watersheds

Table 196. Riparian vegetation departure scores at year 20, Umatilla National Forest

Forested Vegetation Departure	Alt. A Yr. 20	Alt. B Yr. 20	Alt. C Yr. 20	Alt. D Yr. 20	Alt. E Yr. 210	Alt. E-Mod. Yr. 20	Alt. E-Mod. Dep Yr. 20	Alt. F Yr. 20
All watersheds (129)	42.0	41.9	39.9	43.1	41.4	38.2	38.2	40.3
PWS (15)	45.0	44.4	43.7	45.3	43.2	39.8	39.8	37.4
KWS and PWS (52)	39.7	39.8	36.6	40.9	40.1	36.5	36.5	37.1

PWS = priority watersheds; KWS = key watersheds

At year 20, forest vegetation conditions in riparian areas would be the most improved in Alternatives E-Modified and E-Modified Departure, then Alternative C. Alternative D would result in the least improvement. In the modified alternatives, departure values for individual watersheds would range from 28 to 49. In all other alternatives, vegetation departure values would range from 14 to 56, with the range varying by alternative. Alternative C would result in the most watersheds with forested riparian vegetation in least departed condition (47 of 129); Alternatives B, E-Modified and E-Modified Departure would each result in 11 watersheds with forest vegetation within riparian management areas in least departed condition.

Key Indicator: Roads

The 129 subwatersheds on the Umatilla National Forest included in this analysis contain 4,467 miles of existing roads and road density averages 2.0 miles per square mile. The 15 priority watersheds on the Umatilla National Forest contain 735 existing road miles and have an average road density of 1.9 miles per square mile. An estimated 1,500 miles of hydrologically connected roads occur throughout the National Forest, of which 312 miles are in priority watersheds. In this analysis, road density is held constant and the miles of hydrologically connected roads are reduced by the values in Table 198 to estimate the effect of reducing road-stream connectivity on watershed condition. Road density is not assumed to change by alternative for reasons that were explained in the analysis for the Malheur National Forest.

Since 1990, 370 miles of National Forest System roads have been decommissioned, for an average of about 13 miles per year. Some road decommissioning or obliteration is expected to occur under each of the alternatives, but the miles of road to be decommissioned cannot be predicted at this time and requires a site-specific analysis. The focus of this analysis is on the effect of reducing road-stream connectivity in priority watersheds.

Table 197. Miles of decommissioned, open, closed, existing, and total road miles on the Umatilla National Forest Road density in parentheses (2013 data)

Decommissioned	Open	Closed	Existing	Total
370 NA	2,366 (1.08)	2,145 NA	4,512 (2.06)	4,884 (2.23)

NA = not applicable

The objectives for road related restoration and the percentage of hydrologically connected roads in priority watersheds that this represents are displayed in Table 198. For example, in Alternative B, the objective is to treat 260 miles of an estimated total of 312 miles of hydrologically

connected roads in priority watersheds, representing 83 percent of hydrologically connected roads. In Alternatives C, D, E-Modified and E-Modified Departure, the objective miles are higher than the estimated extent of hydrologically connected roads in priority watersheds. In these alternatives, the miles remaining after all roads are treated in priority watersheds are distributed equally among remaining key watersheds. The analysis assumes that road-stream connectivity cannot be completely eliminated, so that some residual effect remains after "all" roads are treated. In this analysis, the residual effect is assumed to be 15 percent of existing roads. Road treatment objectives are not displayed for Alternative A, because similar objectives have not been established for the existing (1990) forest plan.

Table 198. Roads treatment objectives (miles) and percent of hydrologically connected roads that would be treated in priority watersheds for the plan revision alternatives for the Umatilla National Forest

Roads Treatment Objective (first decade)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Roads that would be treated (miles)	260	400	800	300	350	600	270
Percent of roads in priority watersheds	83%	128%	257%	96%	112%	193%	87%

Hydrologically connected roads act as extensions of the channel network. The degree of network extension is calculated by dividing the length of connected roads to length of stream miles in each watershed. Channel network extension reflects both the reduction in time needed for hillslope runoff to be concentrated in stream channels and the corresponding increase in streamflow. The average existing network extension due to roads is estimated to be 16.9 percent for all watersheds, and 22 percent in priority watersheds. Table 199 displays the arithmetic means of network extension by roads for all watersheds, priority watersheds, and key and priority watershed together, by alternative, after road treatment objectives are met.

Table 199. Average estimated channel network extension (percent) by alternative after road treatment objectives are met

Channel Network Extension	Existing	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All watersheds	16.9%	14.0%	14.2%	10.0%	15.2%	14.8%	12.6%	15.2%
PWS	22.2%	3.7%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%
KWS and PWS	11.2%	6.2%	4.5%	1.7%	6.1%	5.4%	1.7%	6.1%

PWS = priority watersheds; KWS = key watersheds

On average, channel network extension in priority watersheds would be reduced from the current level of 22 percent to as low as 3.3 percent in all alternatives except Alternative B, and this may be close to the maximum reduction possible. Additional improvement would also be achieved in key watersheds in alternatives C, D, E-Modified, and E-Modified Departure. Alternatives D and E-Modified Departure would treat the highest percentage of hydrologically connected roads, and could treat all roads estimated to occur in key and priority watersheds, and additional roads in other watersheds. In all alternatives, road-stream connectivity could be negligible in 51 of 129 watersheds, or 40 percent of subwatersheds within 10 years, compared to 39 (30 percent)

subwatersheds currently. In Alternatives D and E-Modified Departure road-stream connectivity would be negligible in half of all watersheds.

The emphasis of road-related treatment objectives, as stated in Appendix A, is to reduce road-related sedimentation by reducing the hydrological connectivity of the National Forest road system. Comparing the objective levels to the estimated 312 miles of hydrologically connected roads, all such roads in priority watersheds would be treated in Alternatives C, D and E-Modified Departure, and nearly all hydrologically connected roads would be treated in Alternative E-Modified.

Roads treatment objectives on the Umatilla National Forest are high relative to the estimate of existing hydrologically connected roads, meaning that the hydrologic influence of the road system in all priority watersheds would be substantially reduced for all action alternatives, and should result in improved conditions in all priority watersheds and most key watersheds as displayed in Table 200 and Table 201. Road treatment objectives are not established for Alternative A, but it is expected that treatment of hydrologically connected roads will be incorporated into future road management and watershed restoration actions.

Road-stream connectivity is lower on the Umatilla National Forest because road density is lower and the layout and design of the forest road system is different than either the Malheur or Wallowa-Whitman National Forests. With similar road treatment objectives, a higher percentage of roads would be treated on the Umatilla National Forest than on the other two national forests. This results in the higher road scores displayed in Table 201 which reflect that road-stream connectivity in priority watersheds and key watersheds is minimized in all action alternatives, compared to the existing condition.

Table 200. Existing and projected model scores for hydrologically connected roads by alternative, after roads objectives in priority watersheds are met for the Umatilla National Forest

Category	Existing Condition	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All Watersheds	0.390	0.466	0.419	0.598	0.387	0.402	0.445	0.387
PWS	0.347	1.000	1.000	1.000	1.000	1.000	1.000	1.000
KWS and PWS	0.668	0.856	0.935	1.000	0.856	0.892	1.000	0.856

PWS = priority watersheds; KWS = key watersheds

Table 201. Combined roads scores (average of road density and hydrologically connected roads evaluation scores) – average scores for all watersheds, priority watershed, and key and priority watersheds for the Umatilla National Forest

Category	Existing Condition	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All WS	-0.063	-0.025	-0.049	0.041	-0.065	-0.058	-0.036	-0.065
PWS	-0.086	0.240	0.240	0.240	0.240	0.240	0.240	0.240
KWS and PWS	0.231	0.325	0.365	0.397	0.325	0.343	0.397	0.325

PWS = priority watersheds; KWS = key watersheds

The difference in model scores between Table 200 and Table 201 reflects the strength of the effect of road density on watershed condition. For all watersheds, combined roads scores on the Umatilla National Forest are near zero (neutral) to moderately positive in key and priority watersheds. Combined roads scores for priority watersheds would be improved relative to existing conditions (scores are positive for all alternatives). The average of combined scores of key and priority watersheds are higher than for priority watersheds alone, because there are fewer roads in key watersheds. The average of roads scores for key and priority watershed together is highest in Alternatives D, E-Modified Departure, and C, and slightly lower than C in the other action alternatives. Expected scores for Alternative A would be higher than the existing condition, but by an undetermined amount.

Key Indicator: Livestock Grazing

Seventy-nine percent of the Umatilla National Forest is suitable for grazing by domestic cattle or sheep. Active allotments currently occur on 60 percent of the National Forest area. Total acres suitable for domestic livestock would be slightly lower in Alternatives B, D, E, and F compared to Alternative A. Total suitable acres would be lower in Alternative C by nearly 60 percent and higher under Alternative D by 4 percent, relative to Alternative A.

Alternative A would support 37,800 animal unit months, Alternatives B, E., and F would support 35,800 animal unit months, and Alternative C 4,200. Alternatives E-Modified and E-Modified Departure would each potentially support 49,200 animal unit months with the increase due to allowing livestock grazing on currently vacant allotments. In this analysis, it is assumed that currently vacant allotments would be grazed, although grazing would not be allowed until the appropriate environmental analysis is completed for each individual vacant allotment.

The change in livestock use, in animal unit months, is used to recalculate relative forage use intensity by alternative. Animal unit months are summed for each individual allotment and allocated to individual watersheds based on the percentage of allotment area in each watershed. Animal unit months are calculated for currently vacant allotments by calculating the number of animal unit months per suitable acre. In the modified alternatives, livestock use increases only within watersheds in which currently vacant allotments occur. Forage use intensity is the ratio of forage consumed by livestock annually to the estimated annual forage production following Holechek et al. (2006) who proposed that keeping forage use below 40 percent of annual production could avoid adverse effects to (herbaceous) forage species.

The calculation of forage use assumes that all areas of an allotment could be used by domestic livestock but forage production in areas known to be unsuitable is given a nominal value of 50 pounds per acre per year so that most of the use is accounted for by the acres that are suitable for domestic livestock. The resulting average use intensity across all 129 subwatersheds and in priority watersheds only is displayed in Table 202. Under existing conditions, no subwatersheds have apparent use intensity higher than 40 percent in any of the alternatives, except E-Modified and E-Modified Departure with one each. Under Alternative C, average use intensity would be less than 10 percent in 128 of 129 subwatersheds and between 54 and 62 subwatersheds in all other alternatives.

Average use levels are expected to be slightly lower than Alternative A in Alternatives B, D, E, and F. Average forage use intensity would be near 1 percent for Alternative C and the greatest calculated forage use intensity in any single subwatershed would be near 10 percent. Average forage use would be higher in Alternatives E-Modified and E-Modified Departure because of the additional acres that would be used by livestock.

Table 202. Average percent forage use intensity in all watersheds and in priority watersheds for each alternative for the Umatilla National Forest

Watershed	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All watersheds	10.6%	10.0%	1.4%	10.1%	10.1%	13.7%	13.7%	10.1%
Priority watersheds	10.1%	10.1%	0.6%	10.1%	10.1%	13.8%	13.8%	10.1%
KWS and PWS	6.2%	6.3%	1.0%	6.1%	6.1%	8.4%	8.4%	6.1%

PWS = priority watersheds; KWS = key watersheds

In Alternatives B and D, utilization of woody riparian species and herbaceous vegetation would be limited to 40 percent of annual growth. The same limits would apply in Alternatives E and F, with the exception that utilization limits would be lower in watersheds inhabited by bull trout, and Alternative F would have slightly lower utilization limits in watersheds inhabited by anadromous fish, than would occur in Alternative E. The stricter guidelines for Alternatives E and F would apply in 35 subwatersheds containing bull trout (550,000 acres or 39 percent of national forest area) and 61 subwatersheds inhabited by anadromous salmon or steelhead (711,000 acres or 51 percent of national forest area).

Alternatives E-Modified and E-Modified Departure would include a guideline, GM-3G, which would allow higher livestock use when desired conditions are being met, but lower allowable use when desired conditions are not being met. GM-3G provides a mechanism for adjusting livestock management based on the status of riparian areas (see Volume 4, Appendix A, text following Table A-32).

Key Indicator: Riparian Habitat Conservation Area and Riparian Management Area Acres

Present management of riparian areas under PACFISH (USDA and USDI 1995) and INFISH (USDA Forest Service 1995) includes the designation of riparian habitat conservation areas. Riparian habitat conservation areas are portions of watersheds where riparian-dependent resources receive primary emphasis. The zones have varying widths: 300 feet on either side of fish-bearing streams and permanently flowing non-fish-bearing streams; 150 feet from ponds, lakes, reservoirs and wetlands larger than one acre; and 100 feet if listed fish are present from seasonally flowing streams, wetlands smaller than one acre, landslides, and landslide-prone areas (50 feet if listed fish are not present). The inclusion of landslide-prone areas could extend the boundaries of riparian management areas beyond these default widths.

Riparian management areas for Alternatives B, E, F, E-Modified, and E-Modified-Departure would use the same basic definitions as riparian habitat conservation areas to define extent, with the exception that widths of 100 feet would apply to all seasonally flowing streams. Riparian management area widths would be 300 feet for all streams in Alternative C. In Alternative D, riparian management area widths would be 100 feet for fish-bearing streams, 70 feet for permanently flowing non-fish-bearing streams, and 50 feet for seasonally flowing streams, which will be higher than Oregon State Forest Practice Rules require for some small streams. Complete definitions of Riparian Management Area widths and the conditions under which they are applied can be found in Appendix A of this document.

Riparian management areas are locations where specific desired conditions, standards, and guidelines apply. Riparian goals in PACFISH and INFISH have been restated as desired

conditions for the action alternatives. The management of riparian management areas and riparian habitat conservation areas would be similar in that work within riparian management areas would have to show progress towards desired conditions, and management actions within riparian management areas would have to demonstrate benefit to aquatic and riparian-dependent resources. Management of riparian habitat conservation areas currently requires that attainment of riparian management objectives not be retarded (USDA Forest Service 1995) whereas the intent of management actions in riparian management areas would be to achieve desired conditions if not already met, or to maintain conditions, if desired conditions are being met.

The acres of riparian habitat conservation areas (Alternative A) and riparian management areas (all plan revision alternatives) and the minimum percent of national forest area that each would encompass are displayed in Table 203.

Table 203. Riparian management area (RMA) acres and percent of Umatilla National Forest for each alternative (riparian habitat conservation areas or RHCAs for Alternative A)

Alt. A RHCAs acres (%)	Alt. B RMAs acres (%)	Alt. C RMAs acres (%)	Alt. D RMAs acres (%)	Alts. E RMAs acres (%)	Alt. E-Mod. RMAs acres (%)	Alt. E-Mod. Dep. RMAs acres (%)	Alt. F RMAs acres (%)
237,500 (17%)	237,500 (17%)	499,800 (36%)	106,900 (8%)	237,500 (17%)	237,500 (17%)	237,500 (17%)	237,500 (17%)

Riparian management area acres would be greatest for Alternative C, which would have 300-foot wide buffers for all streams, regardless of class. Alternative D would have the least acres within riparian management areas because widths would be the narrowest for streams in all categories. Riparian management area widths in Alternative D are based on Oregon Forest Practices guidelines, which do not require riparian management areas for the smallest non-fish-bearing streams with average annual flow of less than 2 cubic feet per second. A review by the Independent Multidisciplinary Science Team (IMST 1999) of the riparian management areas required by the Oregon Forest Practices Act found that riparian management areas required by the act were insufficient to protect aquatic habitats because they were not applied to all streams, and specifically not to non-fish-bearing streams. However, Alternative D, as currently designed, would still apply riparian management areas to intermittent and seasonally flowing streams and therefore exceeds the requirements of the Oregon Forest Practices Act. Riparian management area widths would be the same for all action alternatives, and slightly lower in alternative A. The boundaries of riparian management areas would be extended to include landslide prone areas wherever they are identified.

A discussion of reviews of the effectiveness of riparian buffers is included with discussion of riparian management areas for the Malheur National Forest and will not be repeated here. Based on these reviews, riparian management areas in all action alternatives and the Riparian Habitat Conservation Areas of Alternative A, should be protective of riparian functions if applied correctly. However, riparian functions are not likely to be fully protected by the management area widths proposed in Alternative D. Riparian management areas are expected to be delineated during project planning and resource specialists will identify areas of potentially unstable ground for inclusion within riparian management areas. The riparian management areas in Alternative C would likely be the most protective of unstable areas, as described by Tang and Montgomery (1995). Riparian management area widths in Alternative D would be the least protective of aquatic and riparian-dependent resources, and may not be as efficient as the riparian management

areas in all other alternatives at preventing sediment delivery to streams or providing for inputs of large organic debris, but may still provide most other functions desired of riparian management areas. The inclusion of unstable slopes and landslide prone areas into riparian management areas in Alternatives A, B, E, E-Modified, E-Modified Departure, and F would have an effect similar to increase the width of riparian management areas to account for differences in slope.

Key Indicator: Number of Wetland Sites Improved

Wetlands in National Forest System lands occur in a variety of settings, not all of which are associated with streams or rivers. Based on maps provided for the National Wetland Inventory (NWI) compiled by the U.S. Fish and Wildlife Service, off-channel and isolated wetlands comprise 20 percent or more in area of all wetlands on the Umatilla National Forest. According to NWI maps, there are potentially more than 1,200 small wetlands on the Umatilla National Forest, although the accuracy of the maps is not yet determined. These wetlands are an important component of the hydrology of watersheds within the national forest but are disproportionately important, relative to their size, as habitat for a variety of plant and animal species, and in some cases include species that occur only in specific wetland types. An objective for improvements to or restoration of a small number of these sites each year is included in each alternative. Potential actions include vegetative restoration, hydrologic restoration, and protection by fencing. The objectives levels for restoration of off-channel and isolated wetlands during the first decade of the plan period are displayed separately in Table 204 and incorporated into the restoration objectives displayed in Table 205. Objectives for wetland, riparian, stream channels, and aquatic habitats are not displayed in these tables because they have not been established under the existing (1990) Forest Plan.

Table 204. Objective for wetland site restoration for the plan revision alternatives for the Umatilla National Forest

Wetland Site Restoration Objective (first decade)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Number of sites	25	35	35	40	40	40	35

Key Indicator: Riparian and Stream Channel Restoration

Priority watersheds on the Umatilla National Forest include an estimated 245 miles of perennial streams, based on an average of 16.3 perennial stream miles in each of 15 subwatersheds. Using a nominal riparian width of 25 feet, riparian habitats in priority watersheds encompass an estimated 745 acres. Objectives for stream channel and riparian habitat restoration are summarized in Table 205. The types of restoration actions, but necessarily specific actions, are described in Appendix A of this document.

The objectives for riparian habitat restoration range from 370 to 830 acres or 49 to 112% of riparian habitats in priority watersheds during the first decade of the plan period, compared to approximately 745 riparian habitat acres in priority watersheds within the National Forest (Table 205). The objectives for stream and riparian habitat miles range from 86 to 152 miles, or 35 to 62 percent of stream miles in priority watersheds.

The objectives for stream channel restoration should be sufficient to effectively restore main-stem channels in multiple priority watersheds where restoration actions are most likely to be focused. This analysis recognizes that some objectives overlap in that more than one objective may apply to the same stream reach. As a result, the effect of implementing restoration objectives is treated

conservatively in this analysis. In addition, habitat restoration will likely focus on main-stem reaches with riparian zones wider than 25 feet, but some restoration work could occur on smaller streams in which riparian vegetation may be limited to a narrow fringe that could be only a few feet wide. Alternative C has the highest objective for restoration of stream and riparian habitat miles, Alternative D the lowest. In combination, Alternatives E and E-Modified have the second highest objectives for stream miles and riparian habitat acres restored and Alternatives B and F the lowest. Similar objectives have not been established under the existing forest plan. However, stream, riparian, wetland, and aquatic habitat restoration has occurred, and will continue to occur on the Umatilla National Forest, based on priorities established by the Forest in 2005, and updated through the Watershed Condition Framework in 2011.

Table 205. Passive and active riparian, stream channel, and aquatic habitat objectives for the Umatilla National Forest (expected annual accomplishments)

Objective Statements for the Malheur National Forest	Units	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep	Alt. F
Restore & enhance floodplain connectivity	miles	6	7	5.5	9	9	9	8.5
Restoring riparian & wetland species composition - passive restoration	acres	11	20	11	16.5	16	15	15
Increasing effective stream shade & riparian shrubs	miles	15	30	15	22.5	22.5	22	21
Enhancing off-channel & isolated wetlands*	acres	2.5	3.5	3.5	4	4	4	3.5
Increasing the number & extent of beaver created wetlands	acres	4	7.5	4	5	5	5	4.5
Improving riparian habitat conditions (active & passive restoration)	acres	350	800	600	525	525	500	500
Restoring channel morphology	miles	30	55	30	45	45	42	40
In-channel stream habitat improvement	miles	6	20	6	9	9	8	8.5
Replacing culverts to provide passage to upstream habitat	miles	5	7.5	5	7.5	7.5	7.5	7
Implementing water quality restoration plans	miles	24	32	20	24	24	24	24
Sum of miles	NA	86	152	82	117	117	112.5	109
Percent of stream miles improved	NA	35%	62%	33%	48%	48%	46%	44%
Rank (1= most improved)	NA	6	1	7	2	2	4	5
Sum of acres = 745	NA	368	831	619	551	550	524	523
Percent of Habitat acres improved	NA	49%	112%	83%	74%	74%	70%	70%
Rank (1=most improved)	NA	7	1	2	3	4	5	6

* Isolated wetlands treated as 1 acre per site. B. beaver created wetlands treated as 5 acres per site. Water Quality Restoration Plan miles are the average of range from Appendix A. miles are converted to habitat acres using a channel width of 25 feet. Assuming most work will be done on small streams, this is equivalent to 3.03 acres per stream mile. For comparison of alternatives, highest total is ranked 1; lowest total is ranked 7

NA = not applicable

The assessment of channel condition in this analysis is based on a combination of physical (channel) and riparian attributes (Figure 26). This implies that achieving desired aquatic habitat conditions requires both favorable channel attributes and desired riparian attributes. Based on the percentage of stream miles and riparian acres improved or restored, the change in existing channel condition scores is recalculated by adding 0.2 times the percentage of stream miles improved plus 0.4 times the percentage of riparian acres improved to existing numerical condition scores for each priority watershed. Riparian attributes are weighted higher here because of the influence that riparian vegetation has in maintaining stream channel functions (Naiman et al. 1992).

The resulting average difference in channel condition scores from existing conditions are displayed by alternative in Table 206. Using the same method used in the analysis of watershed conditions on the Malheur National Forest, the result of implementing stream and riparian objectives in priority watersheds results in strong positive gains in conditions in priority watersheds on the Umatilla National Forest (Table 206) relative to all other watersheds. Improvement is greatest in priority watersheds selected as priorities for restoration. The largest improvement occurs in Alternative C, based on model scores for stream and riparian habitat conditions. Slightly less improvement would occur in Alternatives D, E, F and the modified alternatives. Stream channel and riparian conditions would improve relatively strongly in Alternative B, but to a lesser extent than in the other action alternatives. Stream channel and riparian conditions are expected to improve in Alternative A, but to a lesser extent than is displayed in Table 206 for Alternative B.

Table 206. Computed change in channel condition scores resulting from achieving stream channel and riparian habitat restoration objectives on the Umatilla National Forest

Average Score	Existing	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All Watersheds	-0.110	-0.079	-0.043	-0.063	-0.064	-0.064	-0.066	-0.067
PWS	-0.042	+0.225	+0.528	+0.357	+0.349	+0.349	+0.331	+0.328
KWS&PWS	-0.173	-0.096	-0.009	-0.058	-0.060	-0.061	-0.066	-0.067

PWS = priority watersheds; KWS = key watersheds

There may be a stronger long-term benefit in watersheds where restoration restores connectivity between stream channels and floodplains, improves recruitment and establishment of riparian species, and/or results in stable channel configurations, all of which contribute to achieving desired conditions. Riparian and stream channel conditions would benefit further by the planned reductions in the hydrologic effects of roads in the same watersheds, which is expected to alleviate increases in runoff rates and peak flows associated with forest roads.

Other potential actions for channel restoration include placement of large wood, reconnection of side channels, conversion of water rights to restore or protect instream flows, and reintroduction of beaver to suitable sites. Redesign of road-stream crossings is likely to contribute to improved channel and habitat conditions, both upstream and downstream of individual crossings. Improvements to stream channel conditions will also occur in response to expected improvements in upland and riparian conditions, but may take some time to be realized. The intent is to be strategic in choosing where channel reconstruction is done. Active channel restoration may occur in 30 to 60 percent of stream miles in priority watersheds, if needed, and depending in the

alternative selected. The fewest stream miles would be restored under Alternatives B and D, and the most in Alternatives C and E. The extent of channel restoration in the E-Modified alternatives would be similar to Alternative E. The extent of channel restoration in the modified alternatives would be similar to Alternative E. Alternative B was designed to have higher stream, riparian, and aquatic habitat restoration objectives than is currently being accomplished under the existing forest plan (i.e., Alternative A).

Key Indicator: Watershed Condition Class—Number of Watersheds in Improved Condition

The combined effect of the change in upland and riparian vegetation, treatment of hydrologically connected roads, and differences in livestock use between alternatives are used to compute condition scores (Figure 26). Differences in upland and riparian vegetation are based on modeled rates of forest growth, assumptions on the frequency and magnitude of disturbance, and estimates of the rates of timber harvest among land allocations.

In combination, these differences reflect the relative influence of difference in management actions between the alternatives. Results on the Umatilla National Forest are less strongly influenced by high existing road densities than are results for the Malheur National Forest. The Umatilla National Forest has a smaller road system and fewer hydrologically connected roads that may reflect differences in the design and layout of the road system between the two forests. Achieving road treatment objectives on the Umatilla National Forest should substantially reduce the effect of roads and sediment delivery to streams. Additional improvement in watershed condition could still be made by reducing road-stream connectivity in more watersheds and strategically reducing road density by decommissioning roads whose effects cannot otherwise be mitigated.

All watershed restoration objective are expected to be accomplished within 10 years. Changes in vegetation condition are solely responsible for the increase in the number of watersheds improved from year 10 to year 20.

For reasons stated at the beginning of this analysis, road density was not assumed to change. The evaluation of the effects of specific roads on watershed, riparian, stream channels, water quality, and aquatic habitats, and for which the only practical means of reducing or eliminating the effect is to decommission the road, is necessarily outside the scope of this analysis. The identification of roads within 300 feet of streams is a starting point for locating the roads most responsible for sediment delivery to streams, degradation of aquatic and riparian habitats, and water quality. Identification of the treatment needs of these roads is also likely to identify the roads or road segments from which reducing sediment delivery to streams is not possible and are candidates for decommissioning.

Improvements to upland conditions will eventually contribute to improved conditions in riparian and aquatic habitats by moderating watershed hydrology, reducing the rate of watershed runoff, and reducing sediment delivery to streams. Channel response to these changes could take years to decades, and depends to some extent on the frequency and magnitude of future disturbance, and in particular the frequency of large floods relative to channel recovery time.

Table 207 and Table 208 display existing average watershed condition scores and projected watershed condition scores for each alternative. Model scores include changes in upland and riparian forest vegetation, the influence of livestock grazing, reduction of road-stream connectivity, and implementation of stream channel and riparian restoration in priority

watersheds. The greatest potential for improvement in watershed conditions is in Alternative C, but all of the action alternatives would result in improved watershed conditions within priority watersheds by year 10 and continued improvement would occur through year 20. The smaller roads system on the Umatilla National Forest and the increased ability to reduce road-stream connectivity appears the largest influence in improved conditions at year 10. Improvements between years 10 and 20 are due to changes in upland and riparian vegetation conditions and continued improvement of stream channel and riparian conditions.

Table 207. Average of watershed evaluation scores for the Umatilla National Forest at year 10

Category	Existing	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All watersheds	0.038	0.108	0.122	0.290	0.167	0.127	0.078	0.084	0.127
PWS	0.040	0.109	0.229	0.469	0.291	0.266	0.210	0.211	0.264
KWS and PWS	0.153	0.225	0.248	0.387	0.317	0.261	0.232	0.249	0.261

PWS = priority watersheds; KWS = key watersheds

Table 208. Average of watershed evaluation scores for Umatilla National Forest at year 20

Category	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All watersheds	0.125	0.153	0.307	0.176	0.159	0.116	0.115	0.168
PWS	0.119	0.267	0.507	0.316	0.314	0.261	0.256	0.349
KWS and PWS	0.250	0.288	0.416	0.328	0.302	0.280	0.291	0.324

PWS = priority watersheds; KWS = key watersheds

Model scores for watershed condition on the Umatilla National Forest reflect lower departure of upland and riparian vegetation and a smaller and road network, relative to the Malheur National Forest. Reducing the hydrological effects of roads and improvements to forest vegetation condition should moderate any increases in the rates of runoff generation due to forest management.

Separating model scores for all watersheds into upper, middle, and lower thirds, and using the resulting groups to represent condition classes 1, 2, and 3, based on modeled scores for years 10 and 20 shows the relative influence of each alternative in improving watershed conditions in Table 209 and Table 210. The number of watersheds improved in the following tables is the sum of watersheds in which condition improves from class 3 to 2 and from class 2 to 1, relative to the existing condition.

At year 10 alternative C would result in the largest number of watersheds improved, followed by Alternative D. The remaining alternatives would all have lesser improvement in watershed condition and number of watersheds improved at year 10. At year 20, Alternative C would still result in the largest number of watersheds in improved condition, with Alternative D second, but all other action alternatives would result in similar numbers of watershed improved, except for Alternative F. The higher results in Alternative C are partially based on the higher expectancy of watershed restoration. The results at year 20 reflect that improvement in vegetative conditions in the other alternatives begin to make up for some of that difference.

Table 209. Watershed condition classes and subwatersheds in each class along with subwatersheds improved at year 10 for each alternative for the Umatilla National Forest (existing number of watersheds in each class are in parentheses)

Watershed Condition Class	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep. Yr. 10	Alt. F Yr. 10
1 (16)	27	27	57	40	29	28	30	29
2 (107)	101	100	72	89	99	93	91	99
3 (6)	1	2	0	0	1	8	8	1
Subwatersheds improved	11	11	41	24	13	12	14	13

Table 210. Watershed condition classes and subwatersheds in each class along with subwatersheds improved at year 20 for each alternative for the Umatilla National Forest

Watershed Condition Class	Alt. A Yr. 20	Alt. B Yr. 20	Alt. C Yr. 20	Alt. D Yr. 20	Alt. E Yr. 20	Alt. E-Mod. Yr. 20	Alt. E-Mod. Dep. Yr. 20	Alt. F Yr. 20
1	35	35	56	40	34	37	37	37
2	93	92	73	89	95	87	86	92
3	1	2	0	0	0	5	6	0
Subwatersheds improved	19	19	40	24	18	21	21	21

Improved conditions on priority watersheds result from improved vegetation conditions, reduced livestock use, lower road density, and high potential for reducing road-stream connectivity. Improved upland conditions, make it more likely that stream channel and riparian restoration will be effective in the long term by reducing the influence of upslope conditions on watershed runoff rates that contribute to higher peak flows. As displayed in Table 211 and Table 212, all 15 priority watersheds could be in functional condition within 10 years in Alternative C and the number of watersheds improved would increase in all alternatives. All other alternatives would result in a similar, but lower number of functional priority watersheds.

Table 211. Watershed condition classes and priority watersheds in each class along with priority watersheds improved at year 10 for each alternative for the Umatilla National Forest

Watershed Condition Class	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep. Yr. 10	Alt. F Yr. 10
1 (2)	4	5	15	6	6	6	6	6
2 (13)	11	10	0	9	9	9	9	9
3 (0)	0	0	0	0	0	0	0	0
Priority watersheds improved	2	3	13	4	4	4	4	4

Table 212. Watershed condition classes and priority watersheds in each class along with priority watersheds improved at year 20 for each alternative for the Umatilla National Forest

Watershed Condition Class	Alt. A Yr. 20	Alt. B Yr. 20	Alt. C Yr. 20	Alt. D Yr. 20	Alt. E Yr. 20	Alt. E-Mod. Yr. 20	Alt. E-Mod. Dep. Yr. 20	Alt. F Yr. 20
1	4	6	14	6	6	6	6	7
2	11	9	1	9	9	9	9	8
3	0	0	0	0	0	0	0	0
Priority watersheds improved	2	4	12	4	4	5	4	4

No priority subwatersheds would have upslope conditions in class 3 (impaired) at year 10. Most of this change would result from improvements to the road system in these watersheds. Reductions in livestock grazing in Alternative C and increases in Alternative D are the main factor that would place more subwatersheds in condition class 1 in Alternative C at 10 years (15) compared to Alternatives D, E-Modified, and E-Modified Departure (6). Alternative E-modified would have the second highest number of watersheds improved (5) at year 20.

Improvements in upslope watershed condition would be moderated by the fact that the potential net area of detrimental soil disturbance during the first decade of the plan period is expected to be greater by nearly 20,000 acres in Alternative D than in Alternative C because of the levels and types of harvest that are expected to occur (Table 213). Potential detrimental soil conditions resulting from future vegetation management actions would be lowest under C (3,190), A (5,770 acres), and B (6,330 acres) and highest in Alternatives D (16,240 acres) and E-Modified Departure (14,690 acres). The potential for additional detrimental impacts to soils could be reduced or minimized by adherence to soil quality standards, application of best management practices, and the design of future projects, in which impacts could be limited to previously disturbed soils.

Table 213. Acres of detrimental soil conditions and acres improved (treated) at year 10 for each alternative for the Umatilla National Forest (10-year totals)

Soil Condition	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Area disturbed (DSC)	5,770	6,330	3,190	16,240	8,670	8,300	14,690	7,620
Area improved (treated)	NA	7,500	12,500	6,000	9,000	5,750	8,050	9,000
Net acreage	NA	+1,170	+9,310	-10,240	+330	-2,550	-6,640	+1,380

NA = not applicable
DSC = detrimental soil conditions

Detrimental soil conditions influence hydrologic conditions in watersheds by soil compaction and loss of ground cover and an increase potential for surface soil erosion. Sites of detrimental soil disturbance represent an increased risk of sediment delivery to streams, if the sites occur near streams or to hydrologically connected roads. Objective levels for improving soil hydrologic function in areas disturbed by management activities would be lower than the acres of new disturbance alternatives D, E-Modified and E-Modified Departure, and higher in all other

alternatives, resulting in a net improvement in soil conditions. Unless additional actions are taken to protect or improve soil conditions, Alternatives D, E-Modified, and E-Modified Departure would result in net reductions in soil conditions.

Estimates of the existing area of detrimental soil conditions range from 30,000 to 126,000 acres, or 2.1 to 8.9 percent of the national forest. The wide range in estimates of existing detrimental soil conditions, limit the ability to incorporate soil conditions in this analysis. It is likely that some recovery of soil compaction has occurred, based on available literature. However, it also likely that areas subjected to the most severe compaction my take more than 100-200 years to recover completely (Knapp 1989, 1991).

This analysis has likely overestimated the influence of roads on watershed conditions by including closed roads in the calculation of watershed conditions, and in the sum of hydrologically connected roads. The over-estimate of the effect of roads is assumed to offset some, but not all, of the effects of past disturbance to soils.

Alternative C would result in the greatest net reduction in the area of detrimentally disturbed soils, and alternative D the greatest increase. Alternatives B, E, and F are each expected to show small net improvements in soil conditions. Alternatives E-modified and E-modified departure would each have relatively higher impacts to soils unless additional measures were taken to reduce soil impacts unless alternative harvest practices or additional mitigation measures were implemented.

Summary of Effects of the Alternatives on Watershed Conditions on the Umatilla National Forest.

- Alternative D would result in the most improved forest vegetation conditions at years 10 and 20, followed by Alternatives C and E-Modified at year 10, and Alternatives F and E-Modified at year 20.
- Forest vegetation in riparian areas would be most improved in Alternative C at year 10, and Alternative E-Modified at year 20.
- All alternatives have the potential to greatly reduce road-stream connectivity because of the smaller road system on the Umatilla National Forest. The effect of roads on channel network extension could be minimized in all of the action alternatives. Objective miles for treatment of hydrologically connected roads are potentially higher than the miles of roads needing treatment in Alternatives D, E-Modified Departure, C, and E-Modified.
- Livestock use intensity is relatively low on the forest. Use intensity would be reduced further in Alternative C. Livestock use intensity would be reduced to near 1 percent in priority watersheds in Alternative C compared to 10 percent in alternatives A, B, D, E, and F. Average livestock use intensity would increase to near 14 percent in the modified alternatives.
- Improvements would occur on 33-62 percent of stream miles and 49-112 percent of riparian habitats. The greatest improvement in the condition of stream channel and riparian habitats would occur in Alternative C. All revised plan alternatives would potentially have relatively strong improvement in stream channel and riparian conditions in priority watersheds.
- The number of watersheds in Condition Class 1 after 10 years would be highest in Alternative C (57), then D (40), then all other alternatives (27 to 30). The number of

watersheds in improved condition after 10 years would be highest in Alternative C (41), then all other alternatives (11 to 14).

- The number of watersheds in Condition Class 1 at year 20 would be the same as at year 10 in Alternatives C and D, but would continue to improve in all other plan revision alternatives. The number of watersheds in improved condition after 20 years would be highest in Alternative C (56), and D (40), then all other alternatives (18 to 21).
- Five alternatives, including Alternative E-Modified would result in 4 priority watersheds in improved condition at year 10 compared to 13 improved in Alternative C.
- The use of currently vacant allotments by livestock in the modified alternatives increases the number of watersheds that would be grazed. Alternatives E-Modified and E-Modified Departure have the fewest watersheds with forage use intensity less than 10 percent and this appears to affect the condition outcomes at 10 and 20 years relative to the other action alternatives, resulting in fewer watersheds in improved condition.
- Increases in soil disturbance are expected to be highest in the alternatives with the highest levels of mechanical fuel treatment and timber harvest (D, E-Modified, and E-Modified Departure). Four alternatives (C, B, F, and E) could result in net improvements in soil conditions because acres of soil improvements would exceed acres of new detrimental soil disturbance.

Wallowa-Whitman National Forest

The effects of the alternatives are described in the same order as for the Malheur and Umatilla National Forests. Some explanatory text that was included in the description of effects for the Malheur National Forest is omitted:

1. Upslope conditions within watersheds are described in terms of expected changes in the condition of forested vegetation, hydrological connectivity of the road system, and grazing use intensity
2. Differences between alternatives in the effects of grazing on riparian habitats
3. The influence of differences in acres of riparian habitat conservation areas and riparian management areas
4. The influence of restoration actions on riparian, stream channel, and aquatic habitat conditions
5. The influence of proposed riparian, wetland, and stream channel restoration
6. The extent of detrimental soil conditions resulting from expected levels of timber harvest
7. Changes in overall watershed conditions, considering all of the above factors

As in the analyses for the Malheur and Umatilla National Forests, expected changes in vegetation, riparian, stream channel, and watershed conditions are displayed for years 10 and 20.

Key Indicator: Vegetation Condition

The percent of forest area and average departure from desired conditions of each forested potential vegetation group vegetation group on the Wallowa-Whitman National Forest are displayed in Table 214. Dry forest occurs on 34 percent of the Wallowa-Whitman National Forest and is the most departed of the three potential vegetation groups. The combined area of dry forest, cold forest, and moist forest comprises 70 percent of upland vegetation.

Table 214. Percent of national forest and average departure score by potential vegetation group for the Wallowa-Whitman National Forest

Potential Vegetation Group	Percent of Wallowa-Whitman	Average Departure Score
Dry forest	34%	56
Moist forest	18%	23
Cold forest	18%	37

From an analysis of vegetation data aggregated for all potential vegetation groups for the Wallowa-Whitman National Forest, 160 of 166 subwatersheds have vegetation that is moderately departed from desired conditions, and 6 subwatersheds have vegetation that is slightly departed from desired conditions. Vegetation departure used in this analysis describes the existing departure of forest vegetation desired conditions and the expected departure at years 10 and 20 for each alternative. The average departure of forested vegetation at year 10 in all 166 subwatersheds on the Wallowa-Whitman National Forest included in this analysis, priority watersheds, and key and priority watersheds combined, is displayed in Table 215. The greatest improvement in forest vegetation and lowest vegetation departure at year 10, averaged over all watersheds, occurs in Alternative D (37.8), then in Alternatives E-Modified Departure (39.9), E-Modified (40.0), then Alternatives C, B, and F.

Overall forest vegetation condition at year 20 is slightly more improved in Alternative E-Modified than Alternative D as the rate of improvement between year 10 and year 20 is higher in Alternative E-Modified (Table 216).

Table 215. Average of subwatershed forest vegetation departure in all watersheds, priority watersheds, and in key and priority watersheds combined at year 10 for each alternative for the Wallowa-Whitman National Forest

Forested Vegetation Departure	Existing Condition	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep Yr. 10	Alt. F Yr. 10
All WS (184)	46.0	44.6	42.1	41.6	37.8	41.9	40.0	39.9	42.4
PWS (27)	40.9	38.2	36.9	36.5	32.4	37.2	34.9	34.7	37.6
KWS and PWS (77)	45.0	44.9	40.3	39.9	37.7	40.4	38.3	38.2	40.7

Table 216. Average of subwatershed forest vegetation departure in all watersheds, priority watersheds, and in key and priority watersheds combined at year 20 for each alternative for the Wallowa-Whitman National Forest

Forested Vegetation Departure	Existing Condition	Alt. A Yr. 20	Alt. B Yr. 20	Alt. C Yr. 20	Alt. D Yr. 20	Alt. E Yr. 20	Alt. E-Mod. Yr. 20	Alt. E-Mod. Dep Yr. 20	Alt. F Yr. 20
All WS (184)	46.0	43.3	40.2	41.9	37.2	39.9	37.1	39.0	40.2
PWS (27)	40.9	36.5	34.7	36.1	31.4	35.4	32.3	33.8	35.5
KWS and PWS (77)	45.0	42.9	38.0	40.4	37.3	38.3	35.1	36.5	38.1

Riparian Departure

Forested vegetation condition within riparian management areas would improve more by year 10 in alternatives E-modified and E-modified departure, then Alternatives B, C, F, and E average over all watersheds (Table 217). In priority watersheds, average vegetation departure would be lowest in Alternative D (32.4), and average departure in Alternatives E-Modified and E-Modified Departure would be slightly higher than in Alternative D.

At year 20 (Table 218), the departure of forested riparian vegetation would also be lowest in Alternatives E-Modified and E-Modified Departure for all watersheds, priority watersheds, and in key watersheds. In addition, Alternatives B, E, and F would have average departure scores of less than 33 in priority watersheds.

Lower departure (and better condition) in Alternative C than in Alternative D may reflect the difference in riparian management area widths between alternatives but is also influenced by assumptions of harvest rates and the types of activities that are expected in each alternative (more prescribed fire and less harvest volume in Alternative C compared to Alternative D).

Table 217. Average of subwatershed riparian vegetation departure in all watersheds, priority watersheds, and in key and priority watersheds combined at year 10 for each alternative for the Wallowa-Whitman National Forest

Forested Vegetation Departure	Existing Condition	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep Yr. 10	Alt. F Yr. 10
All WS (184)	43.1	40.4	38.5	38.5	42.5	38.4	36.4	36.4	38.4
PWS (27)	39.3	37.1	33.8	34.3	39.9	35.0	32.2	32.2	34.7
KWS and PWS (77)	42.8	38.6	37.7	37.6	40.6	37.7	35.7	35.7	37.6

Table 218. Average of subwatershed riparian vegetation departure in all watersheds, priority watersheds, and in key and priority watersheds combined at year 20 for each alternative for the Wallowa-Whitman National Forest

Forested Vegetation Departure	Existing Condition	Alt. A Yr. 20	Alt. B Yr. 20	Alt. C Yr. 20	Alt. D Yr. 20	Alt. E Yr. 20	Alt. E-Mod. Yr. 20	Alt. E-Mod. Dep Yr. 20	Alt. F Yr. 20
All WS (184)	43.1	37.5	36.5	40.1	42.4	36.5	32.9	32.9	35.6
PWS (27)	39.3	35.0	31.1	35.7	39.7	32.9	28.6	28.6	31.6
KWS and PWS (77)	42.8	33.6	35.4	39.2	40.6	35.7	31.9	31.9	34.7

Key Indicator: Roads

Within the 166 subwatersheds on the Wallowa-Whitman National Forest included in this analysis there are 8,283 miles of existing roads and an average road density of 3.0 miles per square mile. The 27 priority watersheds on the Wallowa-Whitman National Forest contain 1,642 existing road miles and have an average road density of 3.4 miles per square mile. An estimated 3,250 miles of hydrologically connected roads occur within the national forest, of which 658 miles are in priority watersheds. In this analysis, road density is assumed not to change by alternative. Some road decommissioning or obliteration is expected to occur under each of the alternatives, but the miles

of road to be decommissioned cannot be predicted at this time. The focus of this analysis is on the treatment of hydrologically connected roads in priority watersheds.

Table 219. Miles of decommissioned, open, closed, existing, and total road miles on the Wallowa-Whitman National Forest Road density in parentheses (2013 data)

Decommissioned	Open	Closed	Existing	Total
976 NA	4,193 (1.51)	4,090 NA	8,283 (2.98)	9,294 (3.35)

The objectives for road related restoration and the percentage of hydrologically connected roads in priority watersheds that this represents are displayed in Table 220. Objectives are not displayed for Alternative A because similar numeric objectives were not established for the existing (1990) forest plan.

Table 220. Roads treatment objectives (miles) and percent of hydrologically connected roads that would be treated in priority watersheds for the action alternatives for the Wallowa-Whitman National Forest

Roads Treatment Objective (first decade)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Roads that would be treated (miles)	260	400	800	300	350	600	270
Percent of roads in priority watersheds	38%	59%	118%	44%	52%	89%	40%

The emphasis of road-related treatment objectives, as stated in Appendix A, is to reduce road-related sedimentation by reducing the hydrological connectivity of the national forest road system. Comparing the objective levels to the estimated 658 miles of hydrologically connected roads, more than 100 percent of roads could be treated under Alternative D, and 59 percent under Alternative C, 52 percent would be treated under Alternative E, 40 percent would be treated in Alternative F, and 38 percent would be treated in Alternative B. Fifty-two percent of roads could be treated in Alternative E-Modified, and up to 89 percent of roads could be treated in Alternative E-Modified Departure. Higher road treatment is predicted in this alternative because the larger area of timber harvest likely means more road traffic, but provides more opportunity for road-related work.

The existing road system extends the channel network in priority watersheds by an average 35 percent. Hydrologic extension of the channel network due to national forest roads would be reduced to about 5 percent in Alternatives D and E-Modified Departure, and 16 percent in Alternative E-Modified. Road-stream connectivity in priority watersheds would be reduced to 13 to 20 percent in the other alternatives. Road-stream connectivity would be reduced in the largest number of watersheds in Alternative D (see Table 221). Reduction of road-stream connectivity of 490 miles is needed in order to reduce channel network extension to less than 10 percent in priority watersheds. The objective for treatment of hydrologically connected roads exceeds 490 miles only in Alternatives D and E-Modified Departure.

Model scores reflect the positive change in treating hydrologically connected roads (Table 222) compared to the existing condition (Alternative A). Model scores near 1 reflect the assumption

that the hydrological influence of roads in priority watersheds could be nearly eliminated by achieving the road objectives in alternatives D and E-modified. But the effect of remaining roads indicates that roads would still have some effect in priority watersheds (Table 223), and moderate to high effect on non-key watersheds.

Table 221. Average estimated channel network extension (percent) by alternative after road treatment objectives are met

Channel Network Extension Average	Existing	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All watersheds	28.2%	25.7%	24.5%	22.1%	25.3%	24.9%	23.2%	25.6%
PWS	35.2%	20.1%	13.4%	5.3%	18.2%	15.8%	5.3%	19.7%
KWS and PWS	23.4%	20.1%	18.6%	15.4%	19.6%	19.1%	16.8%	20.0%

PWS = priority watersheds; KWS = key watersheds

Table 222. Model scores for hydrologically connected roads on the Wallowa-Whitman National Forest, after roads objectives are met for the Wallowa-Whitman National Forest

Category	Existing Condition	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All Watersheds	-0.196	-0.105	-0.051	0.017	-0.089	-0.101	-0.003	-0.069
PWS	-0.242	0.340	0.687	0.992	0.442	0.365	0.992	0.568
KWS and PWS	0.021	0.180	0.276	0.393	0.208	0.187	0.359	0.243

PWS = priority watersheds; KWS = key watersheds

Table 223. Combined roads scores for the Wallowa-Whitman National Forest, after roads objectives are met for the Wallowa-Whitman National Forest

Category	Existing Condition	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All WS	-0.404	-0.358	-0.331	-0.297	-0.350	-0.356	-0.307	-0.340
PWS	-0.521	-0.230	-0.056	0.096	-0.179	-0.217	0.096	-0.116
KWS and PWS	-0.206	-0.126	-0.078	-0.020	-0.112	-0.122	-0.037	-0.095

PWS = priority watersheds; KWS = key watersheds

Key Indicator: Livestock Grazing

Twenty-four percent of the Wallowa-Whitman National Forest is suitable for grazing by cattle or sheep. Active allotments currently occur on 49 percent of the national forest. Approximately 433,000 acres of the national forest would be considered suitable for livestock grazing for Alternatives A, E and F; 415,000 acres would be suitable for livestock grazing in Alternative B. Suitable acres are reduced in Alternative C to 157,000 acres, increased in Alternative D to 447,000 acres and increased in the modified alternatives to 552,000 acres. The increase in acres suitable for livestock grazing is because currently vacant allotments on the national forest would be suitable for livestock use. The increase in livestock use in the modified alternatives affects

watersheds within currently vacant allotments, but does not change livestock use in other watersheds.

Animal unit months would vary by alternatives, based on differences in suitable acres. Allowable animal unit months for cattle and sheep combined are currently 81,500 (Alternative A) and would be 77,500 in Alternative B; 29,500 with Alternative C; 84,500 in Alternative D; and 80,500 in Alternatives E and F. Animal unit months would be 74 percent lower in Alternative C and 4 percent higher in Alternative D (84,500). The modified alternatives would allow up to 112,000 animal unit months by allowing livestock use on currently vacant allotments. This analysis assumes that vacant allotments would be grazed, although grazing would not be allowed until completion of the appropriate environmental analysis.

Forage use by livestock calculated at 26 pounds of forage per day per animal unit month. Average forage production was calculated for different vegetation types on the Wallowa-Whitman, then aggregated to watersheds using geographic information systems. Forage use intensity is the ratio of forage use to average forage production (Holechek et al. 2006). This analysis follows the assumption of Holechek et al. (2006) that limiting forage use to less than 40 percent of forage production can avoid adverse effects to herbaceous species.

The estimate of average forage use by livestock for each alternative is displayed in Table 224 and ranges from 9 percent in alternative C to 25 percent in Alternatives E-Modified and E-Modified Departure (all watersheds). In priority watersheds, forage use intensity ranges from 2 percent in alternative C, to 24 percent in Alternatives E-Modified and E-Modified Departure.

Table 224. Average percent forage use intensity in all watersheds and in priority watersheds for each alternative for the Wallowa-Whitman National Forest

Watershed	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All watersheds	21%	20%	9%	21%	20%	25%	25%	20%
Priority watersheds	15%	16%	2%	17%	15%	24%	24%	15%
KWS and PWS	14%	13%	4%	15%	13%	18%	18%	13%

PWS = priority watersheds; KWS = key watersheds

The number of subwatersheds with the lowest relative use intensity (less than 10 percent of forage production) would be nearly equal in Alternatives A, B, D, E and F (65 of 184); low relative use intensity would occur in 49 watersheds in each of the modified alternatives and in 121 watersheds in Alternative C.

Low use intensity would occur in 11 of 26 priority watersheds in Alternatives A, B, E, and F. Low relative use would occur in 25 of 26 priority watersheds in Alternative C, 8 of 26 priority watersheds in Alternative D, and 6 of 26 priority watersheds in Alternatives E-Modified and E-Modified Departure.

In Alternatives B and D, utilization of woody riparian species and herbaceous vegetation would be limited to 40 percent of annual growth. The same limits would apply in Alternatives E and F, with the exception that utilization limits would be lower in watersheds inhabited by bull trout, and Alternative F would have slightly lower utilization limits in watersheds inhabited by anadromous fish. The stricter guidelines in Alternatives E and F would apply in 53 subwatersheds containing

bull trout (640,000 acres, 36 percent of forest area) and 88 subwatersheds inhabited by anadromous salmon or steelhead (905,000 acres, 50 percent of forest area). Alternatives E-Modified and E-Modified Departure would include a guideline, GM-3G that allow higher use when desired conditions are being met, but would reduce forage utilization when desired condition are not being met. GM-3G would provide a mechanism for modifying livestock management in allotments with the goal of ensuring that riparian desired conditions can be met (see Volume 4, Appendix A, text following Table A-32).

Key indicator: Riparian Habitat Conservation Area and Riparian Management Area Acres

Present management of riparian areas under PACFISH (USDA and USDI 1995) and INFISH (USDA Forest Service 1995) includes the designation of riparian habitat conservation areas (RHCAs). Riparian habitat conservation areas are portions or zones of watersheds where riparian-dependent resources receive primary emphasis. The zones have varying widths: 300 feet on either side of fish-bearing streams and permanently flowing non-fish-bearing streams; 150 feet from ponds, lakes, reservoirs, and wetlands larger than one acre; and 100 feet if listed fish are present from seasonally flowing streams, wetlands smaller than one acre, landslides, and landslide-prone areas (50 feet if listed fish are not present). The inclusion landslide-prone areas could extend the boundaries of riparian management areas beyond these default widths.

Riparian management areas for Alternatives B, E, F, E-Modified, and E-Modified-Departure would use the same basic definitions as riparian habitat conservation areas to define extent, with the exception that widths of 100 feet would be applied to all seasonally flowing streams. Riparian management area widths would be 300 feet for all streams in Alternative C. In Alternative D, riparian management area widths would be 100 feet for fish-bearing streams, 70 feet for permanently flowing non-fish-bearing streams, and 50 feet for seasonally flowing streams, which will be higher than Oregon State Forest Practice Rules require for some small streams. Complete definitions of Riparian Management Area widths and the conditions under which they are applied can be found in Appendix A of this document.

Riparian management areas locations where specific desired conditions, standards, and guidelines apply. Riparian goals in PACFISH and INFISH are restated as desired conditions for the action alternatives. Riparian management area widths and extent are similar to riparian habitat conservation areas except that a width of 100 feet would apply to all seasonally flowing streams and small wetlands. The management of riparian management areas and riparian habitat conservation areas would be similar in that work within riparian management areas would have to show progress towards desired conditions, and any management activity conducted within them would be designed specifically for the benefit of aquatic and riparian-dependent resources. Management of riparian habitat conservation areas currently requires that attainment of riparian management objectives not be retarded (USDA Forest Service 1995) whereas the intent of management actions in riparian management areas would be to achieve desired conditions if they are not already met, or to maintain conditions if desired conditions are being met.

The acres of riparian habitat conservation areas (Alternative A) and riparian management areas (all action alternatives) and the minimum percent of forest area that each would encompass are displayed in Table 225.

Table 225. Acres and percent of national forest area in riparian management areas (RMAs) for each alternative (riparian habitat conservation areas or RHCAs for Alternative A) for the Wallowa-Whitman National Forest

Alt. A RHCAs acres (%)	Alt. B RMAs acres (%)	Alt. C RMAs acres (%)	Alt. D RMAs acres (%)	Alts. E RMAs acres (%)	Alt. E-Mod. RMAs acres (%)	Alt. E-Mod. Dep. RMAs acres (%)	Alt. F RMAs acres (%)
360,100 (20%)	362,500 (20%)	727,500 (41%)	163,000 (9%)	362,500 (20%)	362,500 (20%)	362,500 (20%)	362,500 (20%)

Riparian management area acres would be greatest for Alternative C, which would have 300-foot-wide buffers for all streams, regardless of class. Alternative D would have the least acres within riparian management areas because widths would be the narrowest for streams in all classes. Riparian management area widths in Alternative D are based on Oregon Forest Practices guidelines, which do not require riparian management areas for the smallest non-fish-bearing streams with average annual flow of less than 2 cubic feet per second. A review by the Independent Multidisciplinary Science Team (IMST 1999) of the riparian management areas required by the Oregon Forest Practices Act found that those required by the act were insufficient to protect aquatic habitats because they were not applied to all streams, and specifically not to non-fish-bearing streams. However, Alternative D, as currently designed would apply riparian management areas to intermittent and seasonally flowing streams and would exceed the requirements of the Oregon Forest Practices Act, but would not likely be protective of all riparian functions.

A discussion of reviews of the effectiveness of riparian buffers is included with discussion of riparian management areas for the Malheur National Forest and will not be repeated here. Based on these reviews, the riparian management areas in Alternatives B, E, F, E-Modified, and E-Modified Departure and the Riparian Habitat Conservation Areas in Alternative A, should be protective of most or all riparian functions. The riparian management areas in Alternative C would likely be the most protective of unstable areas, as described by Tang and Montgomery (1995). Inclusion of unstable and landslide-prone slopes in riparian management areas in Alternatives B, E, F, and the modified alternatives could be as, or more effective than Alternative C in protection unstable slopes. Alternative D would be the least protective of riparian functions, and may not be as efficient as the riparian management areas in all other alternatives at preventing sediment delivery to streams or providing for inputs of large organic debris, but may still provide most other functions desired of riparian management areas.

Key indicator: Number of Wetland Sites Improved

Wetlands in National Forest System lands occur in a variety of settings, not all of which are associated with streams or rivers. Based on maps provided for the National Wetland Inventory compiled by the U.S. Fish and Wildlife Service, off-channel and isolated wetlands comprise 40 percent or more in area of all wetlands on the Wallowa-Whitman National Forest. According to National Wetland Inventory maps, there are potentially 3,000 small wetlands on the Wallowa-Whitman National Forest, although the accuracy of the maps is not yet determined. These wetlands are an important component of the hydrology of watersheds on the forest but are disproportionately important, relative to their size, as habitat for a variety of plant and animal species, and in some cases include species that occur only in specific wetland types. An objective for improvements to or restoration of a small number of these sites each year is included in each alternative. Potential actions include vegetative restoration, hydrologic restoration, and protection

by fencing. The objectives levels for restoration of off-channel and isolated wetlands during the first decade of the plan period are displayed separately in Table 226 and incorporated into the summary of objectives in Table 227. Objectives are not displayed for Alternative A in Table 226 or Table 227 because numeric objectives for these active were not established for the existing (1990) forest plan.

Table 226. Objective for wetland site restoration for the action alternatives for the Wallowa-Whitman National Forest

Wetland Site Restoration Objective (first decade)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Number of sites	25	35	35	40	40	35	35

Table 227. Passive and active, riparian, stream channel, and aquatic habitat objectives for the Wallowa-Whitman National Forest

Objective Statements for the Wallowa-Whitman National Forest	Units	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep	Alt. F
Restore & enhance floodplain connectivity	miles	6	7	5.5	9	9	9	8
Restoring riparian & wetland species composition - passive restoration	acres	15	25	15	22.5	22.5	22	21
Increasing effective stream shade & riparian shrubs	miles	25	50	25	37.5	37.5	35	35
Enhancing off-channel & isolated wetlands*	acres	2.5	3.5	3.5	4	4	4	3.5
Increasing the number & extent of beaver created wetlands	acres	5	10	5	6	6	6	6
Improving riparian habitat conditions (active & passive restoration)	acres	450	1000	800	675	675	600	600
Restoring channel morphology	miles	40	60	40	60	60	50	50
In-channel stream habitat improvement	miles	7.5	23	7.5	11.3	11.3	10	10
Replacing culverts to provide passage to upstream habitat	miles	6	9	6	9	9	8	8
Implementing water quality restoration plans	miles	36	52	20	24	24	24	24
Sum of miles	NA	121	201	104	151	151	136	135
Percent of stream miles improved	NA	28.4%	47.4%	24.5%	35.6%	35.6%	32.1%	31.8%
Rank (1= most improved)	NA	6	1	7	2	2	4	5
Sum of acres	NA	473	1,039	824	708	707	632	631
Percent of Habitat acres improved	NA	36.8%	80.8%	64.1%	55.1%	55.1%	49.2%	49.1%
Rank (1=most improved)	NA	7	1	2	3	3	5	6

The objective levels for riparian improvement in Alternative C are higher than the sum of perennial stream miles in priority watersheds by 74 miles. It is assumed that an equivalent number of miles of riparian habitats would be treated in other key watersheds, so some improvement in riparian conditions would occur outside of priority watersheds. It is also likely that not all riparian habitats are in need of active restoration, so that the objective levels stated may exceed the need in priority watersheds and that more restoration work could be accomplished outside of priority watersheds.

The objectives for stream channel restoration should be sufficient to restore main-stem channels in multiple priority watersheds. This analysis recognizes that some objectives overlap and that more than one objective may apply to a single stream reach or subwatershed. As a result, the effect of implementing habitat objectives is treated conservatively in this analysis. Alternative C has the highest overall restoration objectives for stream channel and riparian habitats. The objectives in Alternative D are also high, but may consist of different actions than in Alternative C as described in the description of alternatives in Appendix A of this document. Stream, riparian, wetland, and aquatic habitat restoration is currently occurring on the Wallowa-Whitman National Forest and is expected to continue at rates lower than have been projected for Alternative B, but in the same watersheds that have been identified as priorities for restoration for this analysis.

The assessment of channel condition in this analysis is based on a combination of physical (channel) and riparian attributes (Figure 26) and is based on the assumption that achieving desired stream channel conditions requires functional riparian habitats (Naiman et al. 1992, Naiman 1995). The numeric results of implementing all objectives for stream channel, riparian, wetland, and floodplain restoration are displayed in Table 228.

Table 228. Computed change in channel condition scores resulting from achieving stream channel and riparian habitat restoration objectives on the Wallowa-Whitman National Forest

Average Score	Existing	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All Watersheds	-0.103	+0.004	+0.037	+0.028	+0.035	+0.077	+0.014	+0.023
PWS	-0.101	+0.003	+0.217	+0.104	+0.090	+0.090	+0.060	+0.059
KWS&PWS	-0.113	+0.073	+0.132	+0.116	+0.129	+0.201	+0.091	+0.108

PWS = priority watersheds; KWS = key watersheds

Highest condition scores are achieved in Alternatives C and D. The results for Alternative D are relatively high but may be based on a different set of actions with a lower condition outcome than is displayed in Table 228. The restoration objectives in the modified alternatives represent well less than half of all stream miles and slightly less than half of riparian habitat miles in priority watersheds.

This analysis identifies the broad types of actions that may occur in priority watersheds, but cannot describe the restoration needs of specific, individual watersheds. In some watersheds, there may be a stronger long-term benefit in restoring floodplain connectivity in some watersheds. Increases in the abundance and volume of large wood in streams appears to be a need in most watersheds, as is increasing the abundance of riparian shrubs and improving the condition of riparian vegetation in general. Riparian and stream channel conditions are also likely to benefit

from improvements in hillslope conditions resulting from improved forest vegetation conditions, and reductions in road-stream connectivity.

The objective for improving riparian areas may be highly varied. Restoring the extent of riparian shrubs and hardwoods along low gradient streams is a priority. Forested riparian areas could be modified with the goal of increasing large wood recruitment potential to streams. Other actions may include restoring floodplain connections, stabilizing stream banks, restoring channel morphology, and planting of desired riparian species. Because channel reconstruction is costly to design and implement, the number of miles completed in any year varies and is usually small.

Key indicator: Watershed Condition Class—Number of Watersheds in Improved Condition

The combined effect of the change in upland and riparian vegetation, treatment of hydrologically connected roads, and differences in livestock use between alternatives are used to compute watershed condition scores (Figure 26). Differences in upland and riparian vegetation are based on modeled rates of forest growth, assumptions on the frequency and magnitude of disturbance, and estimates of the rates of timber harvest among land allocations.

In combination, these differences reflect the relative influence of differences in management actions between the alternatives. Results on the Wallowa-Whitman National Forest are less strongly influenced by high existing road densities than are results for the Malheur National Forest. The Wallowa-Whitman National Forest has a substantial road system but fewer hydrologically connected roads that may reflect differences in the design and layout of the road system between the two forests. Achieving road treatment objectives on the Wallowa-Whitman National Forest should substantially reduce the effect of roads and sediment delivery to streams from the forest road system. Additional improvement in watershed condition is possible by reducing road-stream connectivity in more watersheds and strategically reducing road density by decommissioning roads whose effects cannot otherwise be mitigated.

All watershed restoration objectives are expected to be completed within 10 years. Changes in vegetation condition and improvements in stream channel and riparian habitat conditions are responsible for the number of priority watersheds improved between year 10 and year 20.

For reasons stated at the beginning of this analysis, road density is not assumed to change. However it is noted that the forest has decommissioned 976 miles of roads since 1990, or 35 miles per year on average. The evaluation of the effects of specific roads on watershed, riparian, stream channels, water quality, and aquatic habitats, and for which the only practical means of reducing or eliminating the effect is to decommission the road, is necessarily outside the scope of this analysis. The identification of roads within 300 feet of streams is a starting point for locating the roads most responsible for sediment delivery to streams, degradation of aquatic and riparian habitats, and water quality. Identification of the treatment needs of these roads is also likely to identify the roads or road segments from which reducing sediment delivery to streams is not possible and are candidates for decommissioning.

Improvements to upland conditions will eventually contribute to improved conditions in riparian and aquatic habitats by moderating watershed hydrology, reducing the rate of watershed runoff, and reducing sediment delivery to streams. Channel response to these changes could take years to decades, and depends to some extent on the frequency and magnitude of future disturbance, and in particular the frequency of large floods relative to channel recovery time.

Table 229 and Table 230 display existing average watershed condition scores and projected watershed condition scores for each alternative. Model scores include changes in upland and riparian forest vegetation, the influence of livestock grazing, reduction of road-stream connectivity, and implementation of stream channel and riparian restoration in priority watersheds. The greatest potential for improvement in watershed conditions is in Alternative C, but all of the action alternatives would result in improved watershed conditions within priority watersheds by year 10 and continued improvement would occur through year 20. Priority watersheds contain a relatively high number of hydrologically connected roads. Treatment of 600 to 800 miles of hydrologically connected roads in Alternatives D and E-modified departure would substantially reduce the effects of roads in priority watersheds. The highest overall watershed conditions in priority watersheds would be achieved in Alternative C. The combined effects of improvements in forest vegetation, road treatment, and restoration offsets the effects of increased livestock use and timber harvest to produce a higher condition outcome than in the remaining alternatives. Lower scores in the modified alternatives are due in part from the assumption that livestock use would occur in more watersheds than in the other plan revision alternatives.

Table 229. Average of watershed evaluation scores for the Wallowa-Whitman National Forest at year 10

Category	Existing	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All watersheds	-0.058	-0.021	0.037	0.185	0.037	0.038	-0.010	-0.007	0.046
PWS	-0.018	0.021	0.103	0.399	0.148	0.139	0.032	0.064	0.131
KWS and PWS	0.044	0.081	0.170	0.331	0.173	0.174	0.120	0.124	0.190

PWS = priority watersheds; KWS = key watersheds

Table 230. Average of watershed evaluation scores for Wallowa-Whitman National Forest at year 20

Category	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
All watersheds	0.003	0.061	0.194	0.052	0.063	0.021	0.017	0.073
PWS	0.045	0.129	0.418	0.167	0.166	0.064	0.090	0.162
KWS and PWS	0.110	0.196	0.342	0.188	0.199	0.152	0.152	0.219

PWS = priority watersheds; KWS = key watersheds

Separating model scores for all watersheds into upper, middle, and lower thirds, and using the resulting groups to represent condition classes 1, 2, and 3, based on modeled scores for years 10 and 20 shows the relative influence of each alternative in improving watershed conditions in Table 231 and Table 232. The number of watersheds improved in the following tables is the sum of watersheds in which condition improves from class 3 to 2 and from class 2 to 1, relative to the existing condition.

At year 10 alternative C would result in the largest number of watersheds improved, followed by Alternatives D, E, F, and B. The remaining alternatives would all have lesser improvement in watershed condition and number of watersheds improved at year 10.

At year 20, alternative C would still result in the largest number of watersheds in improved condition (67), with Alternative F second (45), the Alternatives D and E (43 each). The lower outcomes for the modified alternatives relative to the other action alternatives except C, is likely due to the effect of livestock use in more watersheds.

Table 231. Watershed condition classes and subwatersheds in each class along with subwatersheds improved at year 10 for each alternative for the Wallowa-Whitman National Forest

Watershed Condition Class	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep. Yr. 10	Alt. F Yr. 10
1	33	41	64	43	43	36	38	42
2	89	96	81	87	90	86	83	90
3	44	29	21	36	33	44	45	34
Subwatersheds improved	4	19	33	12	15	5	7	14

Table 232. Watershed condition classes and subwatersheds in each class along with subwatersheds improved at year 20 for each alternative for the Wallowa-Whitman National Forest

Watershed Condition Class	Alt. A Yr. 20	Alt. B Yr. 20	Alt. C Yr. 20	Alt. D Yr. 20	Alt. E Yr. 20	Alt. E-Mod. Yr. 20	Alt. E-Mod. Dep. Yr. 20	Alt. F Yr. 20
1	35	43	67	44	44	38	39	45
2	89	96	78	89	91	93	87	90
3	42	27	21	33	31	35	40	31
Subwatersheds improved	6	21	36	15	17	13	8	17

For the Wallowa-Whitman, the largest number of watersheds improved at year 10 is 33 in Alternative C. No more than 15 watersheds are improved in any other alternative. The number of watersheds improved at year 20 is also highest in Alternative C (36). The number of watersheds improved between years 10 and 20 increases in all alternatives, but is highest in Alternative E-Modified (+8) and this appears to be most influenced by upland and riparian vegetation conditions.

Improved conditions on priority watersheds result from improved vegetation conditions, reduce livestock use, reductions in road-stream connectivity, and stream and riparian restoration. Improved upland conditions make it more likely that stream channel and riparian restoration will be effective in the long term by reducing the influence of upslope conditions on watershed runoff rates that contribute to higher peak flows. As displayed in Table 233 and Table 234, all 23 of 26 priority watersheds could be in functional condition within 10 years in Alternative C and the number of functional watersheds improved would increase in all alternatives. All other alternatives would result in a similar, but lower number of priority watersheds in functional condition.

Table 233. Watershed condition classes and priority watersheds in each class along with priority watersheds improved at year 10 for each alternative for the Wallowa-Whitman National Forest

Watershed Condition Class	Alt. A Yr. 10	Alt. B Yr. 10	Alt. C Yr. 10	Alt. D Yr. 10	Alt. E Yr. 10	Alt. E-Mod. Yr. 10	Alt. E-Mod. Dep. Yr. 10	Alt. F Yr. 10
1 (2)	2	6	21	7	7	3	5	6
2 (20)	21	20	5	19	19	23	21	20
3 (4)	3	0	0	0	0	0	0	0
Priority watersheds improved	1	4	19	5	5	4	4	4

Table 234. Watershed condition classes and priority watersheds in each class along with priority watersheds improved at year 20 for each alternative for the Wallowa-Whitman National Forest

Watershed Condition Class	Alt. A Yr. 20	Alt. B Yr. 20	Alt. C Yr. 20	Alt. D Yr. 20	Alt. E Yr. 20	Alt. E-Mod. Yr. 20	Alt. E-Mod. Dep. Yr. 20	Alt. F Yr. 20
1	3	7	23	8	8	4	5	9
2	20	19	3	18	18	22	21	17
3	3	0	0	0	0	0	0	0
Priority watersheds improved	1	5	21	6	6	4	4	7

No priority subwatersheds would have upslope conditions in class 3 (impaired) at year 10 under any of the action alternatives. Alternative C would have the most watersheds in functional Condition Class 1 (23). Alternative C would have the least ground disturbance, lower levels of timber harvest, the least extensive livestock use, and highest stream and riparian habitat restoration objectives. The modified alternatives have greater improvement in forest vegetation condition, slightly lower restoration and road treatment objectives and higher livestock use than the other action alternatives.

Improvements in upslope watershed condition would be moderated by the fact that the area of detrimental soil disturbance during the first decade of the plan period is expected to be greater by nearly 27,000 acres in Alternative D than in Alternative C because of the levels and types of harvest that are expected to occur (see Table 235).

Detrimental soil conditions influence hydrologic conditions in watersheds by soil compaction and loss of ground cover and an increase potential for surface soil erosion. Sites of detrimental soil disturbance represent an increased risk of sediment delivery to streams, if the sites occur near streams or to hydrologically connected roads. Objective levels for improving soil hydrologic function in areas disturbed by management activities would be lower than the acres of new disturbance alternatives D, E-Modified and E-Modified Departure, and higher in all other alternatives, resulting in a net improvement in soil conditions. Unless additional actions are taken to protect or improve soil conditions, Alternatives D, E-Modified, and E-Modified Departure would result in net reductions in soil conditions.

The area of detrimental soil disturbance during the first decade of the plan period is expected to be greater by 27,000 acres in Alternative D than in Alternative C because of the levels and types of harvest that are expected to occur (see Table 235). Alternatives with the greatest projected

amounts of ground based timber harvest would result in the largest number of acres detrimental soil conditions. The net effect of soil disturbance and acres of soils improved results in a net improvement of decline in soil conditions over the life of the plan. Alternative C would have a net improvement of soil conditions of 9,460 acres while alternative D would have a net decline of 17,450 acres. Detrimental soil conditions due to future vegetation management actions would be lowest under Alternatives C (3,040 acres) and B (6,090 acres), and highest in Alternatives D (23,450 acres) and E-Modified Departure (16,960 acres).

Table 235. Potential acres of detrimental soil conditions and acres improved (treated) at year 10 for each alternative for the Wallowa-Whitman National Forest (10-year totals)

Soil Condition	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. E-Mod.	Alt. E-Mod. Dep.	Alt. F
Area disturbed (DSC)	6,740	6,090	3,040	23,450	11,130	10,300	16,960	7,730
Area improved (treated)	NA	7,500	12,500	6,000	9,000	5,750	8,050	9,000
Net acreage	NA	+1,410	+9,460	-17,450	-2,130	-4,550	-8,910	+1,270

NA = not applicable
DSC = detrimental soil conditions

Detrimental soil conditions influence hydrologic conditions in watersheds by soil compaction and loss of ground cover and an increase potential for surface soil erosion. Sites of detrimental soil disturbance represent an increased risk of sediment delivery to streams, if the sites occur near streams or hydrologically connected roads. Objective levels for improving soil hydrologic function in areas disturbed by management activities would be lower than the acres of new disturbance in all alternatives except C, B, and F and are undefined for Alternative A. Unless additional actions were taken to protect or improve soil conditions, Alternatives D, E, E-Modified, and E-Modified Departure would potentially result in an increase in the area of detrimental soil conditions of approximately 17,450, 2,130, 4,550, and 8,910 acres, respectively during the first decade of the plan period. The potential for additional detrimental soil disturbance could be reduced or minimized by adherence to soil quality standards, application of best management practices, and the design of future projects, in which impacts could be limited to areas of previously disturbed soils.

Estimates of the existing area of detrimental soil conditions range from 31,800 to 183,000 acres, or 1.8 to 10.3 percent of the Wallowa-Whitman National Forest. The wide range in estimates of existing detrimental soil conditions, limit the ability to incorporate soil conditions in this analysis. It is likely that some recovery of soil compaction has occurred, based on available literature. However, it also likely that areas subjected to the most severe compaction my take more than 100-200 years to recover completely (Knapp 1989, 1991).

This analysis has likely overestimated the influence of roads on watershed conditions by including closed roads in the calculation of watershed conditions, and in the sum of hydrologically connected roads. The over-estimate of the effect of roads is assumed to offset some, but not all, of the effects of past disturbance to soils. Out of a total of 4,090 miles of closed roads on the forest, 927 miles are in priority watersheds.

Alternative C would result in the greatest net reduction in the area of detrimentally disturbed soils, and alternative D the greatest increase. Alternatives B and F are each expected to show

small net improvements in soil conditions. Alternatives E-Modified and E-Modified Departure would each have relatively higher impacts to soils unless additional measures were taken to reduce soil impacts unless alternative harvest practices or additional mitigation measures were implemented.

Summary of Effects of the Alternatives on Watershed Conditions on the Wallowa-Whitman National Forest

- Alternative D would result in the most improved forest vegetation conditions at year 10, followed by alternatives E-Modified Departure and E-Modified. At year 20, forest vegetation would be most improved in alternative E-Modified, then Alternative D, and Alternative E-Modified Departure.
- Forest vegetation in riparian areas would be most improved in Alternatives E-Modified and E-Modified Departure at years 10 and 20,
- All alternatives have the potential to reduce road-stream connectivity on the Wallowa-Whitman National Forest. The effect of roads on channel network extension could be minimized in Alternatives D and E-Modified Departure. Objective miles for treatment of hydrologically connected roads are potentially higher than the miles of roads needed treatment in Alternative D. No objectives are identified for Alternative A. It is likely that the identification and treatment of hydrologically connected roads will occur regardless of the alternative selected.
- Livestock use intensity is relatively moderate on the national forest. The acres suitable for livestock grazing would be greatly reduced in Alternative C. Livestock use intensity would be reduced to less than 2 percent in priority watersheds in Alternative C compared to 15-18 percent in Alternatives A, B, D, E, and F. Average livestock use intensity would increase to near 24 percent in the modified alternatives.
- Improvements would occur on 24-47 percent of stream miles and 36-81 percent of riparian habitats. The greatest improvement in the condition of stream channel and riparian habitats would occur in Alternative C. Riparian and stream channel conditions would improve in all plan revision alternatives. Restoration objectives in Alternative E-Modified would improve conditions in 32 percent of stream miles in priority watersheds and 55 percent of riparian habitats. Improvements to stream channel and riparian habitats would continue under Alternative A at rates that are similar to, or slightly less than are projected for Alternative B.
- The number of watersheds in functional condition after 10 years would be highest in Alternative C (64), then D and E (43), then all other alternatives (33 to 42). The number of watersheds in improved condition after 10 years would be highest in Alternative C (33), then all other alternatives (5 in Alternative E-Modified to 19 in Alternative B).
- The number of watersheds in Condition Class 1 between years 10 and 20 would increase by 1 to 3 in all alternatives. The number of watersheds in improved condition after 20 years would be highest in Alternative C (67), and F (45), then all other alternatives (34 to 44).
- Alternative C would result in 19 watersheds in improved condition at year 10. All other alternatives would result in 5 or fewer watersheds improved.
- The use of currently vacant allotments by livestock in the modified alternatives increases the number of watersheds that would be grazed. Alternatives E-Modified and E-Modified Departure have the fewest watersheds with forage use intensity less than 10 percent (49) and this appears to affect the condition outcomes at 10 and 20 years relative to the other

action alternatives, resulting in fewer watersheds in improved condition. In Alternative C, livestock forage use intensity would be less than 10 percent in 121 watersheds.

- Increases in soil disturbance are expected to be highest in the alternatives with the highest levels of mechanical fuel treatment and timber harvest (D, E, E-Modified, and E-Modified Departure). Three alternatives (C, B, and F) could result in net improvements in soil conditions because acres of soil improvements would exceed acres of new detrimental soil disturbance.

Comparison of Effects of the Alternatives on each National Forest

The combination of improved vegetation condition, reduction in the acres suitable for livestock use, treatment of hydrologically connected roads, and stream and riparian habitat restoration in Alternative C results in the largest improvement in watershed conditions and largest numbers of watersheds improved on each of the national forests.

On average forest vegetation is more highly departed on the Malheur National Forest than either the Umatilla or Wallowa-Whitman National Forests. In general, the alternatives with the highest levels of vegetation and fuels related treatments tend to make the most progress towards desired conditions, but progress towards desired conditions also depends on the types of treatment.

- Alternative E-modified results in the most improved forest vegetation conditions on the Malheur National Forest at years 10 and 20 and the most improved forest vegetation within riparian management areas
- Alternative D results in the most improved vegetation conditions on the Umatilla National Forest at years 10 and 20, but there is a greater difference between Alternatives D and E-Modified at year 10 than at year 20
- On the Wallowa-Whitman National Forest, forest vegetation is most improved by Alternative D, then E-Modified at year 10 and by Alternative E-Modified then D at year 20.

Forest roads appear to have the greatest effect on watershed conditions on the Malheur National Forest and least effect on the Umatilla National Forest.

- Objectives for reducing road-stream connectivity on the Malheur National Forest range from 260 to 650 miles per year, depending on the alternative, compared to an objective of 925 miles needed to reduce channel network extension due to roads in priority watersheds to less than 10 percent. However, this analysis has included 1,375 of closed roads in priority watersheds an unknown number of which are, or are not hydrologically connected to streams. An initial assessment is that half of these roads may not be sources of sediment to streams, but the actual number is unknown. Including closed roads in the analysis offsets some of the detrimental effects to forest soils on watershed conditions, but overestimates the number of hydrologically connected roads by an unknown amount.
- Objectives for reducing road-stream connectivity on the Umatilla National Forest range from 260 to 800 miles, depending on alternative, and this represents 83 percent to more than 100 percent of the estimated number of miles of hydrologically connected roads on the forest. Three hundred and seventeen out of 2,133 miles of closed roads occur within key watersheds. Road-stream connectivity is overestimated, by an unknown but lesser amount than for the Malheur National Forest.
- Objectives for reducing road stream connectivity on the Wallowa-Whitman National Forest also range from 260 to 800 miles, depending on alternative, or 38 percent to more than 100

percent of the estimate of hydrologically connected roads in priority watersheds on the forest. This estimate includes 927 miles of closed roads, which may or may not be connected. As above, closed roads were included in the analysis to offset some of the effects of detrimentally disturbed soils on watershed condition,

The area suitable for livestock grazing is greatly reduced in Alternative C, increased in Alternative D, and increased further in Alternatives E-Modified and E-Modified Departure. The difference in effect is that fewer watersheds are grazed by livestock in Alternative C. Alternatives E-Modified and E-Modified Departure would have the highest number of watersheds with livestock grazing and this results in fewer watersheds in functional condition and fewer watersheds improved an all three national forests.

Restoration objectives improve stream and riparian habitat conditions slightly on the Malheur and Wallowa-Whitman National Forests and moderately to strongly on the Umatilla National Forest. The difference is partially due to the magnitude of objectives relative to the number of stream miles in priority watersheds. Similar objectives result in higher outcomes in the Umatilla National Forest because there are fewer priority watersheds with fewer stream miles to improve or restore. The same situation applies to treating road-stream connectivity.

Estimates if detrimental soil disturbance due to past timber harvest summarized in the soils section of this document are:

- 44,200 to 249,900 acres on the Malheur National Forest
- 23,100 to 118,700 acres in Umatilla National Forest
- 31,800 to 183,140 acres on the Wallowa-Whitman National Forest

This is in addition to the potential net soil disturbance that will accrue in the alternatives with the highest levels of timber harvest and mechanical fuels treatment (Alternatives D and E-Modified Departure).

Of most interest in this analysis are the acres of soils that are disturbed by compaction because of its effect on soil infiltration, moisture distribution within soils, surface erosion, and runoff generation in watersheds. The recovery rate of soils from compaction depends on soil texture, depth, moisture content, and the severity of compaction. Studies of soil compaction recovery indicate that recovery is slow; few studies have observed or measured soil compaction recovery for time periods longer than 10 years, although a few have re-measured sites that were disturbed as long as 40 year earlier. The minimum time from for full recovery from soil compaction during tractor logging appears to be longer than 40 years (Vora 1988) and recovery from the most severe compaction may require longer than 200 years (Knapp 1989, 1991).

Cumulative Effects

Past impacts on watersheds in the Blue Mountains have resulting from the removal of beaver from about a 1820 through 1840, mining (from about 1861), logging from the early 1860s, agriculture, water diversions, changes in the fire regime due to fire suppression, log drives, splash dams, railroads, livestock grazing, stream channelization, levee construction, and road construction.

Present and ongoing actions that affect watersheds include stream and riparian habitat restoration on each national forest, on adjacent lands by other state and federal agencies, Tribes, and watershed councils. Water quality restoration plans are implemented following completion of

total maximum daily loads by the Department of Environmental Quality in Oregon and Ecology in Washington. On the national forests, the two most common causes of water quality degradation are increased stream temperature and increased fine sediment in streams, measured either as turbidity or as suspended sediment. Reductions in stream temperature are increasingly associated with restoration of riparian habitats to increase stream shade, but may also include, restoration of channel morphology and the acquisition of instream water rights by State agencies, Reductions in sediment delivery may include measures to reduce road-related erosion, streambank stabilization, and measures to reduce surface soil erosion.

Future actions include ongoing restoration work described above, continued timber harvest on State, Federal and Private lands, water diversion downstream of the national forests, and climate change.

Mining

Placer mining began in the Blue Mountains by 1862 with discovery of gold near Baker City, Granite and Canyon City. Different forms of placer mining (panning, ground sluicing, hydraulic, dredging) have different effects. Arguably the greatest impacts were from dragline and bucket line dredges that operated on the John Day River at Prairie City, near John Day and Canyon City and downstream to near Mt. Vernon. Dredges operated on the Powder River near Sumpter, on the North Fork John Day River near Granite, and on the Middle Fork John Day River near Galena. Large placer operations occurred in the upper Powder River, Marble Creek in the Elkhorn Mountains, on Eagle Creek and Pine Creek in the Wallowa Mountains. The main effect of placer mining on streams is the disruption of channel bed and banks, and the disruption or elimination of riparian vegetation. Some of the earliest water diversions are associated with placer mining and some still exist. Dredging in the upper John Day, Middle Fork John Day, North Fork John Day, and Powder Rivers has left sections of each river channelized and isolated from its former floodplain.

Logging

The earliest logging in the Blue Mountains dates at least to the 1870s. Early logging occurred more often in streamside forests because they were more accessible and because the trees were often larger.

Log drives on the upper Grande Ronde River occurred as early as 1874 and continued to 1919. Splash dams operated at five sites on the upper Grande Ronde River from 1889 to 1919. Log drives also occurred on Catherine Creek, Lookinglass Creek, the Wallowa River, and the Minam River. In the Grande Ronde basin and in the North Fork Malheur River. Log drives scoured channel bed and banks and damaged riparian vegetation. Removal of wood in streams that prevented log transport was a common practice.

Splash dams were used on the Grande Ronde, Minam, and North Fork Malheur rivers to facilitate transportation of logs to downstream lumber mills. Splash dams were operated by the Oregon Lumber Company on the Grande Ronde River between 1889 and 1919, but log drives may have occurred as early as 1874 (Farnell 1979). Log drives are known to have occurred on the Minam River, Lookinglass Creek, Catherine Creek, Wallowa River, the North Fork Malheur River, and may have occurred on other streams in the Blue Mountains. Log drives were typically accompanied by the removal of instream wood and other obstructions that would prevent log transport (Sedell et al. 1991). Wood removal reduces flow resistance, releases stored gravel downstream, and reduces channel stability, but the log drives themselves were capable of

scouring streams to bedrock and eroding stream banks. Timber harvest has been continuous from about the 1870s to the present. Records of logging from the period 1960 to present are available in GIS. Logging from before 1960 are less well documented and records are less readily available.

Channelization

A review of satellite imagery of the rivers that originate on the national forests indicates that channel and floodplain alteration is widespread. Indications are that at least some channel degradation was occurring by the 1930s on the South Fork John Day, Middle Fork John Day, and Grande Ronde Rivers, and in many cases before 1900.

Channelization of the Grande Ronde River occurred by 1870 with construction of the State Ditch which reduced river length by an estimated 40 miles. Large wood was removed from the Grande Ronde River to facilitate log drives over approximately 35 river miles upstream of La Grande.

Railroads isolated sections of floodplain on the Grande Ronde, Powder, John Day, and other rivers (McIntosh et al. 1994, Michelsen-Correa 2011). Channel constriction by railroads, roads, and levees confines flood flows and contributes to channel degradation, in part because straightening of stream channels makes them steeper, resulting in higher flow velocity and higher sediment transport capacity (Leopold, Wolman, and Miller 1964). Studies of gully evolution in Colorado (Graf 1977) and channel response of large rivers to dams (Williams and Wolman 1984) suggest that headward erosion is initially more rapid and slows over time, suggesting that channel incision and subsequent headward erosion are more likely to occur soon after original impact, rather than later. Gully formation creates a change in base level for tributary streams as channel erosion progresses upstream so that tributary streams are likely to adjust by channel erosion to the new base level (Leopold 1972, Knighton 1998). Erosion depth tends to decrease upstream as stream energy declines. Terraces are formed by the upstream passage of a headcut, followed by the development of a new floodplain at a lower elevation; Murderer's Creek on the Malheur National Forest is an example.

Water Diversion

Irrigated agriculture accounts for about 98 percent of all water uses in the rivers that emanate from the Blue Mountains. Among the first actions by white settlers in the Blue Mountains were the conversion of floodplain vegetation to livestock use and farming and the diversion of water from area streams for irrigated agriculture. Initially water was diverted from stream and conveyed by ditch lines to irrigated fields. Sprinkler irrigation began by the 1950s. The past several decades have seen an increase in use of groundwater for irrigation,

Railroads

Completion of a rail line through La Grande occurred by the mid-1880s and was followed by the construction of rail lines along the major headwater tributaries of the Grande Ronde River. Perry and Baker City were connected by rail by 1890, and lines extended to Sumpter by 1896 and to Prairie City by 1910. Railroad logging continued into the 1930s until truck transportation became feasible.

Roads

After about 1940 most log transportation was by truck. Road miles doubled on the Wallowa-Whitman national forest between about 1950 and 1980, then doubled again between 1980 and 1990 (McIntosh 1992), and coincided with the peak period of timber harvest from the national

forests. Available harvest records indicate that logging occurred on 1.6 million of 5.5 million acres on the national forests between about 1960 and 2004, and that approximately 80 percent of timber harvest in this period occurred in the years between about 1978 and 1995. Road construction was likely coincident with harvest and also peaked between 1980 and 1995.

Fires

Fire suppression, increases in ladder fuels, and increases in stand density have all contributed to an increase in fire frequency in recent decades. Wildfires can result in greatly increased erosion rates, hillslope instability, increased flood risk, debris flows, and increased runoff until forest vegetation recovers. Based on available records, more acres were burned by wildfires in the Blue Mountains in one year (1910: 554, 000 acres) than in any decade through the 1990s. From 1960 through 2009, the acres burned by wildfires per decade have increased nearly exponentially from 44,460 acres in the 1960s to nearly 700,000 acres between 2000 and 2009 (Table 236).

Table 236. Acres burned by decade in the Blue Mountains national forests

Decade	Acres Burned
1960s	44,564
1970s	21,963
1980s	257,876
1990s	363,761
2000s	695,252

In the analysis of watershed conditions, fire history was not explicitly included, but is assumed to be at least partially accounted for in the condition of forest vegetation as represented by vegetation departure scores. In this analysis, decreased vegetation departure is assumed to reduce the risk of uncharacteristic wildfire.

Effects on Hydrology

Timber harvest and roads have been implicated in increases in the magnitude of peak flows, increases in bases flows, and changes in the timing of peak flows. One mechanism for increases in peak flow magnitude by logging is reduced evapotranspiration that results in increased soil moisture and causes increased soil moisture during rain events. In snow-dominated watersheds, the pattern of cutting in individual watersheds can result in increased snow accumulation and earlier melting of snow. A summary by Grant et al. (2008) that changes in peak flows due to timber harvest are generally detectable in floods of moderate frequency and magnitude (floods that occur at intervals of approximately 10 years or 1ess) and that harvest effects on larger floods are generally not detectable (statistically). The effect of timber harvest varies between snow-dominant and rain-dominant watersheds. The effects of roads on watershed runoff depend on how roads interact with local streams, but also on the location of roads relative to areas of timber harvest. More surface and subsurface runoff is intercepted by roads located downslope of harvest units and by mid-slope roads than by valley bottom. Roads with inboard drainage ditches become active parts of the channel network when water table elevations in adjacent hillslope intersect the ditch level. Faster runoff in spring may result in lower summer stream flow, but this is difficult to demonstrate in the Blue Mountains because the majority of stream gage sites are on larger rivers where it is difficult to detect the change.

Effects on Channel Morphology

Removal of wood from stream and rivers was common where log drives occurred. "Stream cleaning" to remove wood obstructions from area streams continued into the 1980s. Removal of instream wood reduces flow resistance and reduces channel stability. With or without the effects of log drives, wood removal from streams, in conjunction with riparian logging is very likely to have affected channel stability in area rivers by the 1930s. Most of the wood that enters streams is from trees that grow in a zone within about 100 feet of the stream edge (Reeves et al. 2016). Between 1964 and 2004, 14 to 24 percent of the area within 100 feet of streams on the national forests were logged, and roads were constructed within 100 feet of streams along 5 to 24 percent of stream miles during the same period. The result of early logging within riparian areas, combined with removal of wood from streams has been both a reduction in instream wood and decline in the sources of wood recruitment to streams.

As described earlier in this section, PACFISH-INFISH Biological Opinion monitoring data suggests that the difference in wood abundance between managed and reference reaches is on the order of 17,000 to 50,000 board feet per mile and equates to a potential deficit of instream wood in area streams of 100 million to 450 million board feet of wood on each national forest. The actual difference remains to be determined but depends on harvest and disturbance history, vegetation type, growth potential, and determination of the potential distribution of wood along area streams. Based on these and other factors, the potential wood frequency is likely to vary between watersheds (Hough-Snee et al. 2015). Regardless, it appears clear that wood frequency in area streams is greatly reduced and that the potential for wood recruitment has been affected by logging as early as the 1870s through the present.

The importance of instream wood in pool formation, channel stability, and sediment storage, combined with the apparent magnitude of wood loss make managing riparian areas for improved recruitment of large wood a critical need. It is pointed out that the intent of establishing riparian management areas is that management actions will be designed for the benefit of aquatic and riparian habitats. With this in mind, standards and guidelines are included in the Aquatic and Riparian Conservation Strategy in the preferred alternative to guide timber harvest and also to guide the management of livestock.

It also important to understand that large trees are not always the dominant riparian vegetation. Depending on the setting, valley width, gradient, channel type and other factors, riparian zones may currently, or have the potential to be dominated by riparian shrubs, including willow, dogwood, and alder, may naturally have been meadows dominated by obligate wetland herbs, were composed of gallery forests of cottonwoods, or included aspen. An examination of PACFISH-INFISH Biological Opinion monitoring sites in the Blue Mountains suggests that as many as 20 percent of sites occur in reaches in which the potential dominant vegetation is not large conifers; in addition local survey data suggests that the dominant bank vegetation on as much as half of perennial streams, is a combination of riparian shrubs, hardwoods, and herbaceous species.

Channel shape is guided by relative differences in erodibility between channel bed and banks (Leopold and Maddock 1953). Channels will erode by widening if banks are weaker or by lowering bed elevation until a resistant layer or bedrock is encountered. Incised streams may go through stages of development or evolution following channel incision (Bledsoe et al. 2002, Watson et al. 2002) and may recover to near their original form (Rosgen 1994).

Incised streams may initially form by erosion of the channel bed. Elevated sediment transport rates without an increase in sediment supply can lead to the development of an armored bed that is resistant to erosion, as well as pool formation, and can result from the conversion of a gravel-bed pool riffle streams to a coarse bedded plane bed streams (Montgomery and Buffington 1993). Ultimately, incised streams may behave like urban streams that become larger to accommodate the increased flow that they must carry (Hammer 1972, Wissmar et al. 2004). In unconfined valleys, most streams will widen by bank erosion following channel incision and increased sediment delivery may cause aggradation of downstream reaches.

A review of the Grande Ronde river upstream of La Grande suggest that channel and floodplain erosion may have removed 15 to 20 million tons of sediment between about 1900 and the present. Flow records and the construction of a preliminary sediment rating curve suggests that up to half of this sediment could have been removed by the 10 largest floods of record. The present channel and tributaries of the Grande Ronde river lack sediment storage capacity and it appears that sediment transport capacity exceeds sediment supply and that each successive flood tends to maintain the present degraded state rather than contribute to channel and habitat recovery.

In contrast, estimates of road surface erosion rates suggest that 3,000 miles of existing roads in the upper Grande Ronde River produce 5,000 to 30,000 tons of sediment per year, but typically a fraction of this sediment reaches streams. Roads are known to intercept subsurface flow on hillslopes and convert subsurface flow to surface runoff that is concentrated in streams more quickly. Because the effect occurs with every runoff event, roads have a persistent effect on the hydrology of forested watersheds. However, because runoff pathways become increasingly complex in larger watershed watersheds, the effect may be severe in small watersheds, but undetectable in large watersheds (Grant et al. 2008). Because up to 75 percent of existing forest roads in the upper Grande Ronde subbasin were built after 1950 and as many as half after 1980, road are less likely to have been the original source of channel erosion or sediment but likely contribute to the alteration of the present hydrology and sediment budget of the upper Grande Ronde River.

Incised streams lose hydrologic connectivity with adjacent flood plains. The frequency of overbank flows is reduced, the duration of water surface elevation is altered and water level drops more rapidly, all of which influence riparian species composition, establishment, and survival (Stromberg and Patten 1992, Stromberg 2013, Cooper et al. 2006, Merritt and Wohl 2002). Rooting depth of many riparian species is about 1 meter, or 3.3 feet (Manning and Padgett 1989). Although some riparian phreatophytes have roots that can reach water tables and depths of several meters, 1 meter approximates the rooting depth of plant species that contribute most to bank stability. Changes in water level of less than 1 foot can result in changes in riparian species compositions due to different inundation tolerances and water requirements of riparian plant species. Bank stability may be lost more quickly if the combined change in hydrology and channel morphology results in loss of deep rooted riparian species and replacement by shallow rooted upland species.

Figure 35 shows a hypothetical channel with a top width of 30 feet and mean depth of 1.5 feet, corresponding to a bankfull width-to-depth ratio of 20; typical of a Rosgen “C” channel type. The zero elevation represents the floodplain, or bank elevation. The dashed line represents an incised stream in which the channel bed has eroded an additional 1.5 feet. The new channel bed sits at an elevation 3 feet below the level of the original floodplain. Maintaining the original top width gives the incised stream an apparent width-to-depth ratio of 10. The new average water surface elevation is equivalent to the original bed elevation if not other changes occur, but the same flow

level no longer overflows onto the floodplain. The width-to-depth ratio of the incised stream is in the range of Rosgen "E" channels, but the new channel is more characteristic of a gully, or Rosgen "G" channel.

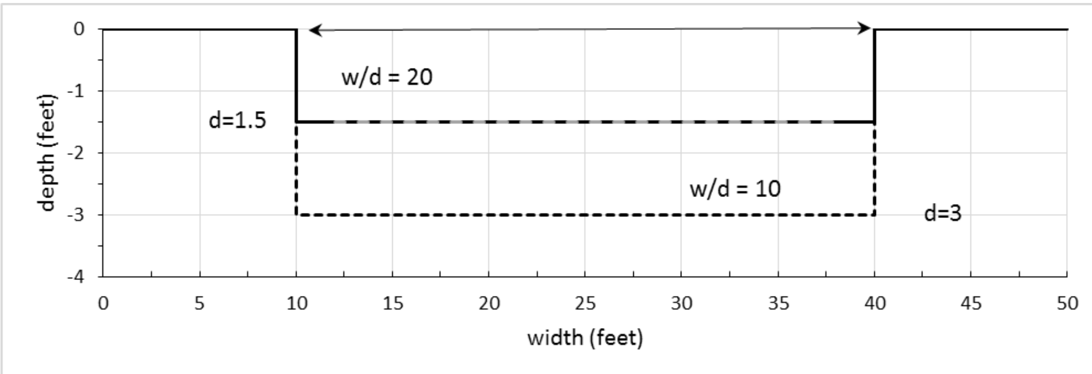

Figure 35. Hypothetical channel with a top width of 30 feet and mean depth of 1.5 feet, corresponding to a bankfull width to depth ratio of 20 – typical of a Rosgen "C" channel

Channel response to changes in stream flow and sediment supply is context dependent and influenced by channel type, land use and disturbance history, and flood history. Stream channels with different properties vary in their response potential and magnitude of response to disturbance (Montgomery and Buffington 1993, 1997; Montgomery and MacDonald 2002) and this information can be used to distinguish disturbed streams from undisturbed streams or to determine channel condition (Woodsmith and Buffington 1996).

A potential mechanism of improved riparian conditions in areas of highly-departed dry forest is moving these stands from existing overstocked, dense stands of younger trees towards open stands of old trees. Liquori and Jackson (2001) have shown that areas that historically had open stands of Ponderosa pine along streams often had willow species in the understory, and that stream reaches with willows had much lower width-depth ratios (narrower channels) than streams lined with dense stands of young Ponderosa pine.

Water Quality and Water Uses

Streams within National Forest System lands in the Blue Mountains that do not meet state water quality criteria are generally listed on state 303d lists due to high stream temperatures or high suspended sediment loads, or both. Within National Forest System lands, it is assumed that improvements in overall watershed condition will contribute to improved water quality of streams within individual forests, and that improvement in forested vegetation condition and decrease of the influence of forest roads will contribute to improved water quality.

Both Oregon Department of Environmental Quality and Washington Department of Ecology base their analyses of total maximum daily loads, at least in part, on the maintenance of stream shade provided by riparian vegetation. Both agencies acknowledge a number of other factors that contribute to increased stream temperatures, but recognize that improvements to or increases in riparian conditions and stream shade are more likely to result in improvements to water quality.

Downstream of the forests, livestock grazing is the dominant land use on BLM lands, and livestock grazing and irrigated agriculture are the dominant uses of most private lands within the analysis area. Water withdrawals affect stream temperature by reducing the volume of flow and

increasing the effect of solar radiation on stream temperature. Water withdrawals affect stream temperature indirectly by decreasing the integrity of riparian vegetation and decreasing bank stability. Based on data for the 1995 water year, water withdrawals from all basins totaled 2.7 million acre-feet, or 38 percent of total runoff (Solley et al. 1998). Consumptive use was 1.3 million acre-feet, or 18 percent of total runoff. Because more than 90 percent of water in the Blue Mountains is used for irrigation, most water is diverted during the growing season with diversion beginning on March 15 or April 1 and ending September 30 or October 15, depending on the basin and state water right duty schedules. Water withdrawals have the greatest effect on water volume at the same time, July and August, when air temperatures and solar radiation are highest. On average, consumptive water use during the growing season is nearly 60 percent of total streamflow from all rivers and exceeds 90 percent in some river basins with the largest areas in irrigated agriculture.

The influence of National Forest System management on downstream water quality varies by river basin, the extent of downstream water use, the season of use, and the volume of flow relative to the flow of receiving waters. Rivers that begin in National Forest System lands in the Blue Mountains drain to the Snake River, Columbia River, or to the Closed Basins of eastern Oregon. The total flow of all rivers that begin in National Forest System lands is about 5.5 percent of the flow of the Columbia River at the Dalles, Oregon. The effect of individual rivers on downstream water quality also varies because they enter the Snake or Columbia Rivers at different points; effects are further moderated by management of dams for hydroelectric power and flood control is a dominant effect on flow and sediment regimes of the larger rivers.

Effects of Climate Change

Climate change, because it results in changes in the hydrologic cycle due to changes in temperature and precipitation, including the form of precipitation, has the potential to fundamentally alter watershed processes and disturbance regimes over the next several decades. Average temperatures in Oregon are expected to increase by 3 to 7 degrees Fahrenheit by mid-century and 5-11 degrees Fahrenheit by the 2080s if greenhouse gas emissions continue to increase (Dalton et al. 2017). Temperature changes are projected to be lower if greenhouse gas emissions level off, which would result in warming of 2-5 degrees Fahrenheit by mid-century and 2 to 7 degrees Fahrenheit by the 2080s.

Warmer temperatures are already affecting the hydrology of the Blue Mountains. Trends toward reduced winter snow, earlier snowmelt, more precipitation falling as rain instead of snow, earlier spring runoff, and lower summer flows have been documented throughout the western U.S. and Pacific Northwest (Mote 2005, Stewart 2009, Cayan et al. 2001, Luce and Holden 2009). These trends are expected to continue. Precipitation may increase slightly in the Pacific Northwest, but summers are expected to become warmer and drier. Reduced snowfall and earlier snowmelt are expected to result in earlier runoff timing and lower summer stream flow.

Winter snow accumulation and spring snowmelt account for 70 to 80 percent of streamflow in the Blue Mountains, or 3.5 to 4.0 million acre-feet of water, on average. In contrast, reservoir storage within the Blue Mountains accounts for less than 400,000 acre-feet of water used primarily for irrigation. Snowmelt runoff can last into August from some high elevation watersheds and sustains streamflow into late summer. April 1 snow-water equivalent (SWE) is a measure of the water available to become streamflow later in the year and it has been in decline in the Blue Mountains. At Aneroid Lake in the Wallowa Mountains, from about 1940 to the present, April 1 snow-water equivalent has been declining at a rate of 3 to 4 percent per decade (Figure 36).

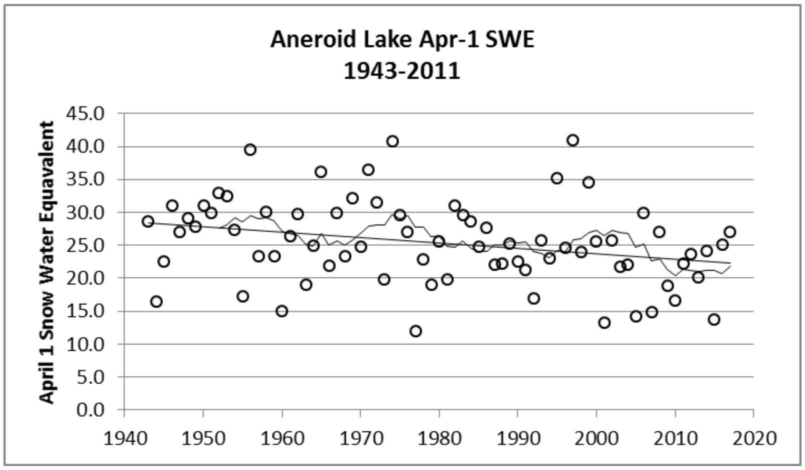

Figure 36. Aneroid Lake, April 1 Snow Water Equivalent 1943-2016

Groundwater is a major contributor to summer streamflow. Groundwater moves within fractures, faults and permeable layers within some rock formations, such as the Columbia River Basalt. In the northern Blue Mountains, the basalts are folded and slope towards Pendleton and Walla Walla to the west and the Grande Ronde River to the east. Water transported in in permeable layers in the basalt escapes as springs when these layers intersect the ground surface, and enters streams when permeable layers and streams intersect. Groundwater may mediate the effects of reduced snowmelt but most groundwater is ultimately recharged by precipitation and will eventually respond to changes in the type and amount of precipitation. Groundwater may mediate some of the effects of climate change because groundwater inflow may buffer some changes in streamflow due to variability in precipitation Safeeq et al. (2014).

In particular, snowpacks in the Pacific Northwest are expected to be highly sensitive to warming, especially in areas where winter temperatures are near freezing. April 1 snow water equivalent (SWE) has been declining for the past few decades across the western U.S. (Mote 2003) and the Blue Mountains (Luce et al. 2014). Runoff from snowmelt may occur earlier in the season, and the amount of runoff resulting from snowmelt is expected to decline in response to warming temperatures in coming decades. By the end of this century, late season runoff from snow may be restricted to higher elevations, if it occurs at all. Decreases in snowmelt runoff imply earlier runoff timing and lower summer streamflow for most, if not all streams. Consistent with this change February and March streamflow has been higher during the 30 year period ending in 2010 than for the period 1941-1970 at all 16 gage sites with the longest periods of record in the Blue Mountains and June streamflow has been lower at 15 of 16 sites. These changes are indicative of shift in streamflow timing that is consistent with the expected effects of warming temperatures.

Climate change is expected to increase the frequency of rain-on-snow floods and winter flood peaks (versus spring snowmelt flood peaks), and increasing temperature is likely to increase drought risk because of reduced water storage for summer use and the long-term variability of dry years and wet years in the Pacific Northwest. Winter stream flow is expected to become higher and more variable as temperatures increase (Isaak et al. 2016). Increased stream water temperatures may increase the extent and duration of lethal or sub-lethal stream temperatures for cold-water fish species in lowland rivers, particularly bull trout, but also to cold-water fish species in general.

Changes in temperature and the timing and magnitude of rainfall will influence the distribution and composition of forest and nonforested vegetation. Increased atmospheric carbon dioxide may

reduce vegetation water demand, but the magnitude of the effect has been a subject of scientific debate (Huntington 2008). Over time, increased temperature is expected to result in substantially higher vegetative water requirements due to increased evapotranspiration, and the predicted small increases in precipitation in the region are unlikely to be large enough to compensate for the effect of increases in temperature. As a consequence of increased vegetative growth, water demand by vegetation is likely to increase and there could also be increased risk of drought mortality, increased insect and disease risk, and greatly increased fire risk.

Cumulative effects on watershed, aquatic, and riparian dependent resources will depend, to a large degree, on the extent to which watershed restoration and vegetation management actions contribute to resilient landscapes. Under all alternatives, the desired conditions for watershed, aquatic, and riparian dependent resources are for the maintenance or restoration of the processes responsible for creating and maintaining healthy and productive watersheds. While some of these conditions may be more difficult to attain under climate change, achieving these conditions is most likely to result in landscapes resilient to expected climate changes, at least for the 10 to 20 year planning period.

National Forest System lands in the Blue Mountains encompass parts of 25 subbasins and 15 river systems. Most of these basins have multiple ownerships with differing management goals. In several river basins, the dominant land use is irrigated agriculture and water use is high relative to available streamflow. Actual streamflow is 10 percent or less of natural streamflow during the growing season in several basins with the highest irrigation water demand. Aquatic habitat connectivity is low, at least seasonally, in these areas. In addition, water supplies are fully appropriated in most, if not all, river basins in the Blue Mountains. The basins in which current water use is highest, relative to water supply, are likely to be the most at risk if expected climate changes are realized, because water demand will increase as temperature increases and water availability is likely to decrease.

Effects from the Alternatives

None of the alternatives would alleviate potential climate change, but all alternatives include or allow for management actions that would improve the ability of national forest resources to adapt to a changing climate. Objectives for reductions in road-stream connectivity are important, because they aid in reducing the effect of the forest road system. Actions that reduce runoff from forest roads will also contribute to “storm proofing” the forest roads systems. Movement of forest and riparian vegetation towards desired conditions, and reduction in the effects of roads, and moderate the rate at which watershed runoff is concentrated in streams. This moderates peak flows and reduces erosive energy of stream flows.

On the Umatilla National Forest, Alternative D results in faster movement towards desired conditions for forest vegetation at year 10 and year 20, but forested riparian improves at a faster rate in Alternative E-Modified. On the Wallowa-Whitman National Forest, vegetation conditions are more improved under Alternative D than Alternative E-Modified at year 10, but Alternative E-Modified results in more improved conditions by year 20. On the Malheur National Forest upland and riparian forest vegetation improve more rapidly in Alternative E-Modified at years 10 and 20 than in any of the other alternatives. The combination of improving forest vegetation, reducing road-stream connectivity and implementing restoration in Alternative E-Modified approaches the level achieved in Alternative C, but the increase in areas suitable for livestock grazing in the modified alternatives offsets other benefits of the modified alternatives.

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